The Journal

OF THE

British Astronomical Association.

EDITED BY E. WALTER MAUNDER, F.R.A.S.

TENTH SESSION :—
OCTOBER 1899 TO OCTOBER 1900.

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British Astronomical Association.

VOL. X. SESSION 1899–1900. No. 1.

REPORT OF THE ANNUAL MEETING OF THE ASSOCIATION, HELD ON OCTOBER 25, 1899, AT SION COLLEGE, EMBANKMENT.

W. H. MAW, F.R.A.S., *President*, in the Chair.

J. G. PETRIE, F.R.A.S., } *Secretaries.*
W. SCHOOLING, F.R.A.S., }

The *Secretary* read the Minutes of the previous Annual Meeting, which were confirmed.

The *Secretary* read the list of presents received, and the thanks of the Association were accorded to their respective donors.

The names of 13 candidates for admission were read and passed for suspension, and the election by the Council of one new Member was confirmed.

Mr. Petrie read the Report of the Scrutineers of the Ballot.

The *President* said all the Members had received a copy of the statement of accounts for the past Session, and he, as Treasurer, would be pleased to give any explanations with regard to them that might be desired. On the whole, it was by far the most favourable statement he had had the pleasure of submitting. They had written a very substantial sum, over 28*l.*, off the value of their stock of journals; they had added 6c*l.* to the reserve fund; and they had a surplus of income over expenditure of over 63*l.* The number of Members in arrear was much less than a year ago, and a very substantial proportion of those in arrear last year had paid up—45 out of 80. Unfortunately, a large proportion of the arrears in respect of the past Session was due to

the Australian Branches. There were 71 Members in arrear for the last Session, and 19 of those were Australian Members. The arrears, excluding the Australian deficiencies, represented under five per cent. of the main body of Members, by far the best result they had had for some years.

The accounts were then unanimously adopted, as was also the Report of the Council for the past Session.

Col. Burton-Brown proposed a cordial vote of thanks to the retiring Members of the Council, Mr. Cottam, Sir Wm. Huggins, Mrs. Maunder, and Dr. Isaac Roberts. The Association, he said, had made its way owing, to a large extent, to the untiring energy, zeal, and ability of the Members of the Council. Not only had they on the Council men of note and distinction, but men who were hard workers, and it was their cordial co-operation which had led to the prosperity achieved. Then they had been favoured by the fact of two or three eclipses of the sun having taken place in the period during which the Association had existed, and, if all were well, they were going to have another in May next. He hoped to go to Algiers to witness it, and if, as he proposed, he went out in advance of the main body of the Association's expedition, he would be glad to render them any personal service in his power.

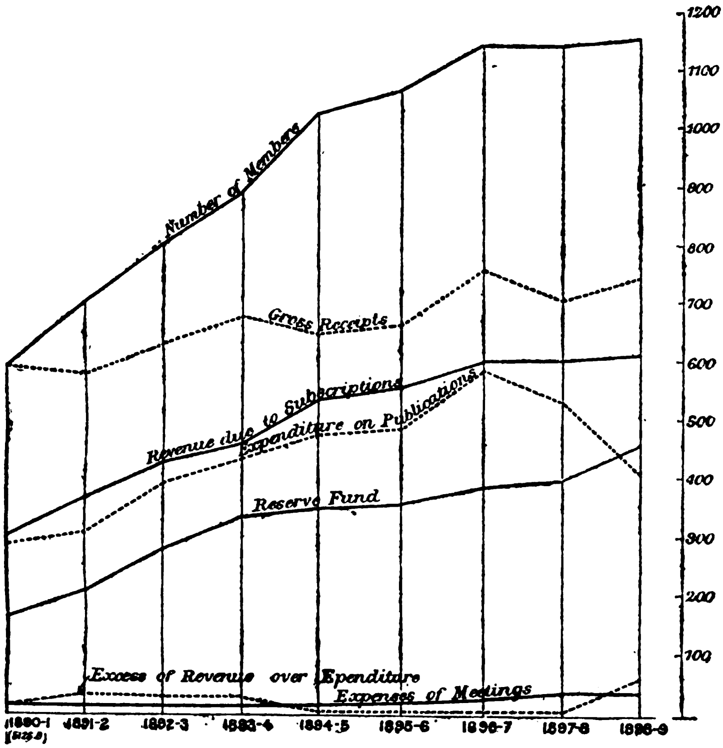
Mr. Crawford seconded the motion, and it was approved.

On the proposition of *Mr. J. D. Hardy*, seconded by *Mr. Cottam*, the thanks of the Association were tendered to Messrs. Miller and Ellis, the Auditors; and a similar vote of thanks was accorded to Messrs. Crawford, Adams, and Holmes, the Scrutineers of the Ballot, at the instance of Mr. Ellis and Dr. Smith.

The *President* then delivered the following Presidential Address:—

With the present meeting the British Astronomical Association commences its Tenth Session, and inasmuch as it has been my duty as your Treasurer during the past nine years to look after the finances of your Society, it may, perhaps, naturally be expected that now, when I address you as President, I should say something concerning the progress which the Association has made, and the position in which it at present stands. To some extent the reasons for my taking such a course have, however, been removed by the manner in which your Vice-President, Mr. Wesley, when addressing you last year, laid clearly before you the facts relating to our growth of membership, and pointed out the conclusions which may be drawn from the character of that growth. Under these circumstances I do not propose to occupy your time by going over quite the same ground, but there are other points connected with our development to which I do desire briefly to direct your attention.

It is always somewhat tedious to listen to the reading of a number of figures, and I have therefore thought it best to put into the form of a diagram such statistics as I wish to lay before you.



This diagram (reproduced on the present page) is divided vertically into nine spaces corresponding to the nine years of the life of the Association, and it bears on it seven lines showing respectively the following data:—

(1.) Number of members;
(2.) Total receipts during each Session;
(3.) Revenue due to subscriptions only;
(4.) Expenditure on publications;
(5.) Amount of reserve fund;
(6.) Expenses of meetings;
(7.) Excess of gross receipts, after deducting additions to reserve fund, over expenditure.

On each of these items I shall have a few words to say.

The first thing suggested by an examination of this diagram is that our Society is not one which can be said to have sprung from small beginnings. It is true that our membership has nearly doubled since 1891, but an Association which attained a membership of 586, had gross receipts amounting to 595*l.*, and managed to put 170*l.* to its reserve fund, during its First Session, cannot be said to have started in a very small way. That such results were attained shows, I think clearly, both that the Society was wanted, and that those by whom it was set on foot went the right way to work to get the necessary support.

The next thing shown by the diagram is that a good start has been followed by a steady progress. The rate of that progress has varied, as from a number of causes it must necessarily do; but there has been no going back, and no year in which we have failed to pay our way, and add something to our reserve.

So much for the general features of the diagram. I will now deal briefly with each of the items to which the horizontal lines correspond. First, then, as to our membership. As was pointed out by Mr. Wesley, last year, our rate of increase has on the whole, been a gradually decreasing one. I say "on the whole" because the increase of Session 1894–5 over 1893–4 formed an exception to the general rule, this being due to special circumstances connected with the Norwegian eclipse expedition. Let us hope that the arrangements for observing the eclipse of May next may lead to a similar exceptional increase of our roll during the Session now commencing. Last year we had, for the first time, to report no increase in membership, the figures for the Sessions 1896–7 and 1897–8 being identical; but during the Session just past we have again progressed, although our increase has been small, namely, eight members only, making our total 1,152. I do not, however, regard these figures as indicating that we have even now closely approached the probable limit of our membership, but rather as showing that we should take steps for developing fresh districts in which, as yet, little has been done. The establishment of our provincial branches has always been attended by an increase of membership, and there are several districts, notably in the south and south-west of England, and in Ireland, where such branches ought to meet with substantial support. Our membership, large as it is, for a society of this kind, really represents but a very moderate fraction of those strongly interested in astronomy in this country, a class which I am glad to say is, with the spread of scientific knowledge, steadily extending every year.

Next, as to the line denoting our gross receipts, and that showing the revenue due to subscriptions. It will be convenient to consider these two lines together. The first of them, as its name denotes, embraces receipts of every kind—such as life membership compositions, entrance fees, donations, &c. in addition to regular subscriptions; and the sums which it represents are thus naturally variable, both in amount and character from year to year. A drop in this line during any one Session, therefore, does not necessarily mean a lack of prosperity during that Session, but may be simply due to fewer additions to the life-member class. The succeeding line, namely, that showing the revenue due to subscriptions, is, on the other hand, of much greater interest, representing as it does the sums available for meeting current expenditure as distinguished from expenditure on what may be called capital account.

At the time when our Association was started the fixing of the amount of the annual subscription was a matter which received much anxious consideration, and when at length this subscription was fixed by a vote of the Members at 10*s.* 6*d.*, there were many of us who had considerable doubt as to whether, with that very

moderate contribution it would be possible to carry out the publication of the "Journal" and "Memoirs" in the way which we felt to be so desirable. Thanks, however, to the vast amount of work gratuitously performed by our Editors, and by those who have assisted in the preparation of Abstracts, &c., and thanks also to the liberal donations we from time to time received—and notably from the late Miss Brown—the difficulties of our early days were tided over, and I think we can now fairly say that we have thoroughly proved the practicability of carrying on, even with such a small annual subscription, a society like ours issuing publications of real value, without being led into financial difficulties. At the same time our margin for special expenses is but a small one, and it behoves us all to do everything we can to increase this margin by enlarging the number of our Members.

The fourth line on the diagram—that marked "Expenditure on Publications" is one deserving careful attention. When our Association was founded it was unanimously agreed by those responsible for its management that the only way to secure a permanent success was to issue in connexion with it publications which would adequately record the work of the Society. It was felt that an Association like ours to be really successful must not be in any sense a local society, but that it must include Members, not only in all parts of our own country, but in all parts of the world. How thoroughly this aim has been realised our list of Members now shows. But this wide-spread support evidently means that a very large proportion of our Members can never—or but very rarely—attend our meetings, and to them the publications are everything, and really represent the Association. Bearing this fact in mind it has always been the policy of your Council to spend on the publications all that the Association could afford, and the diagram shows clearly how large a proportion of our revenue due to subscriptions has been so spent.

Up to the present we have published nine volumes of our "Journal," and six complete volumes of "Memoirs," with portions of two other volumes, and we have done this at a cost of 3,918*l.*, an amount equal to over $87\frac{1}{2}$ per cent. of our revenue due to subscriptions. Each member has, therefore, had seven-eighths of his subscription returned to him in the form of publications, valued only at their monetary cost to the Association. But as I have already stated our publications have only been rendered possible by the vast amount of gratuitous work performed in connexion with them—notably by our valued friends Mr. and Mrs. E. W. Maunder—and as a matter of plain fact it would be quite impossible for our "Journal" and "Memoirs" to be published commercially at anything like their cost to our Members. This year we have produced, in addition to our regular publications, an admirable report of the expeditions to view the eclipse of the sun in India last year, and this has been issued to Members at a price which would have been quite impossible had not the editorial work been all done gratuitously, and had not the Eclipse Committee received substantial financial aid. As it is, it is only by a good sale of the report that the expenses incurred in producing it can be, even approximately, recouped, and I trust

that those Members who have not yet secured a copy will do so without delay.

The three remaining lines in the diagram call for but brief comment. The fifth line, showing the amount of our reserve fund, will, I think, be regarded as recording very satisfactory results, and all I need say concerning it, is that the present amount of our reserve is substantially in excess of the present capitalised value of our life-Members' composition fees. It may be added that in calculating our reserve, no credit has been taken for our books, book-cases, instruments, lantern, lantern-slides, &c., although these really represent assets of considerable value.

The sixth line recording the expenses of our meetings is of interest as showing how very small a proportion of our expenditure is devoted to these gatherings. Finally, we have the seventh line indicating the excess of revenue over expenditure, a line which in some Sessions approaches uncomfortably close to the base line, but which, you will be all glad to see, has a substantial elevation at the end corresponding to the Session just completed.

Having thus dealt briefly with the past history and present position of our Association, I have next to say something of its future prospects as they appear to present themselves to me. Our Society has now reached such a stage of development that the composition of its Membership may be regarded as fairly representative of what it is likely to be for many years to come; and it is thus possible to form a just idea of the work which the Association can profitably undertake, and of the value which such work is likely to possess.

Roughly, our Members may be divided into three classes, viz.:—First, the professional astronomers, connected with established observatories, and having at their disposal, more or less ample instrumental equipment. Second, amateurs having instruments fitted for serious work and possessing, moreover, a fair amount of experience in the use of such instruments. And third, Members who are students of astronomy, but who are either not possessors of instruments at all, or who have not facilities for observational work of an original kind. This third class may possibly be advantageously subdivided as I shall indicate later on.

As regards the first class, the professional astronomers, it is, I am sure, a great satisfaction to us all that we have been able to enrol so many of them in our ranks. A reference to our list of Members will show that it includes professional astronomers in nearly every civilised country, men whose names are household words, and the history of whose work constitutes to a great extent the history of the recent progress of our science. It is impossible to overrate the value to our Association of the collaboration of these professional astronomers. Their contributions to our publications may be comparatively few, for, as a rule, the accounts of their researches are, almost of necessity, issued through other channels; but we are indebted to them for some very valuable papers, while we have constantly benefited by their presence at our meetings and by their aid in various ways. Without them the status of our Association would certainly not be what it now is.

Next, as to the second class, that consisting of amateurs possessing more or less excellent instrumental equipments. It is this class which has formed the backbone of our observing sections, and to it is due the bulk of the original work which has been recorded in the publications of the Association. In the admirable address delivered from this chair last year by our valued Vice-President, Mr. Wesley, special reference was made to the organisation of our observing Sections, and to the excellent work which those Sections have done and are still doing. It will be quite unnecessary for me to go again over the ground which Mr. Wesley covered so thoroughly, but I do wish to strongly endorse the views which he expreesed as to the value of the feature which these observing Sections have formed in our organisation, and as to the great debt we owe to the Directors by whom these Sections have been controlled. Unfortunately, we have to mourn the loss during the past year of one of the most valued of these Directors, Miss Brown, but if anything could console us for this loss, it is the knowledge that the work which she so ably inaugurated, and which she carried on until the last with such conspicuous ability and enthusiasm, will be continued with the most conscientious thoroughness under the new Director, Father Cortie.

It is satisfactory to know that this second class of our Members, upon whom we depend so much for original work, is an ever growing one, while year by year it is becoming possessed of more powerful and more perfect instruments. And this brings me to a point on which I wish to say a few words, namely, the influence of the large telescopes, with which some of our more important observatories are now provided, on the usefulness of the work of amateur observers. In considering this point it must be borne in mind that the great telescopes of the present day are of a very different class from the giant instruments of the past. The great reflectors of Herschel, of Lassell, and of Rosse were all instruments made and used by amateur astronomers, and although they possessed great light-grasp and did some admirable work, they were, owing largely to the nature of their mountings, utterly unfitted for the class of observations on which the large telescopes of the present day are chiefly employed. The 36-in. and 60-in. reflectors of Dr. Common may, perhaps, be regarded as the latest of this older class of large telescopes, although it would probably be more just to consider Dr. Common's instruments as forming a connecting link between the giants of the past and present.

In the case of such large refractors as those at Pulkowa, at Washington, at Vienna, at Mount Hamilton, at Nice, at the Yerkes Observatory, and at Greenwich the cost of the telescope itself is but a small portion of the total outlay incurred. Not only must such an instrument be thoroughly well mounted to fit it for modern research work, but it must be protected by a well constructed dome, and, in order that every moment of good seeing may be utilised, provision should be made for effecting all movements of both telescope, and dome with the least possible amount of labour to the observer using the instrument. How perfectly this can be done is well shown by the great Yerkes refractor, which, notwithstanding its enormous size and weight, can, with its dome, be so readily handled by the electric motors

with which it is provided, that it can be—and is—efficiently used by a single observer through a whole night, without any assistance whatever. It is satisfactory to know that two of our own Members, Messrs. Warner and Swasey, were responsible for both the design and construction of this admirably perfect mounting, while the rising floor, which forms such an important feature in the equipment of both the Yerkes and Lick Observatories, and contributes so much to the convenient use of these large telescopes, is the invention of another of our Members, Sir Howard Grubb.

But by the time a refractor of this kind has been erected and equipped the outlay upon it will have become so large, that it would be utter folly to use the instrument for work other than that for which its great power renders it specially fitted. The result of this is that our modern giant telescopes are, with few exceptions, employed, not in doing work which was formerly done by smaller instruments, but in doing work which formerly could not be done at all. Such, for instance, is the bulk of stellar spectroscopic work, including determinations of velocity in the line of sight, the measurement of close double stars, the spectroscopic examination of nebulæ, the discovery of new planetary satellites, and similar matters. We see, therefore, that the establishment of these powerful telescopes has been accompanied by the development of new fields of research, and that the work which was formerly done—and can still be well done—by instruments of moderate size, has not been reduced. On the other hand, many professional astronomers have withdrawn from the work which they formerly did with the instruments then available, and they have thus left to amateur observers the continuance of their former labours.

We thus see that there is ample work for the Members forming our Observing Sections, and that such work, if faithfully carried out and recorded with judgment and discrimination, is calculated to be of great and permanent value.

This brings me to a somewhat delicate point on which it is, I think, my duty to say a few words :—I mean the character of the reports of our Observing Sections. Now the report of a Section may be of two kinds, namely, it may be a simple record of all the work done by the Members of that Section; or it may be a digest of the facts which the labours of the Section have elicited. A report of the first kind possesses the advantage that it gives full credit for the work of individual observers, and so far acts as an encouragement to further efforts ; but one is apt to rise from the perusal of such a report with a very confused idea of what it all means, and as a document for reference it certainly leaves much to be desired. A report of the second kind, on the other hand, if carefully drawn up by an observer having special experience in the matters dealt with, such as the Director of a Section naturally possesses, is a work not merely of great present interest, but of permanent value, and adds materially to the standing of the society by which it is published. If our funds were abundant we might, no doubt with advantage, give our sectional reports a dual character, publishing more or less in full the records of individual observations, and adding a digest of the

facts deduced by the Director from those observations. In this way we should be imitating the procedure of a Royal Commission, which accompanies its report by a reprint of the evidence on which that report is founded. But, unfortunately, our funds are far from being abundant, and we are, therefore, bound to practice strict economy, and to endeavour to spend our money so that it may be of the greatest benefit to our Members generally. It is thus eminently desirable that our sectional reports should be of the character of digests of facts prepared by the Directors, and that the engravings should be only such as are required to illustrate these facts and render clear points which cannot be so well explained verbally. I fear that the adoption of this course may lead to some disappointment of individual workers, and to the non-publication of many admirable drawings which, if our funds allowed, we should be most desirous to reproduce. I hope, however, that Members of Sections will see the necessity of the course I have foreshadowed, and that they will, at all events for the present, be content with a less full record of their individual work than that to which they may possibly deem they are entitled.

And this brings me to another point, namely, the mode of recording the work of our Sections. While it is at present impossible for us to print anything like full records of the work of individual observers, it is eminently desirable that such records should be available for future reference. In order that this end may be conveniently attained, however, it is essential that the reports of the observers forming any Section should be sent to the Director in some uniform style, and written on paper of a standard size. The selection of the form of the individual reports is, of course, to a great extent a matter to be decided by the Directors of Sections; but I think that all Directors might agree as to a uniform size and character of paper, and I would suggest ruled foolscap would be as convenient as any. Every report of an observation, however brief, should be written on paper of the standard size, the writing being on one side only, and a broad margin being left on the left-hand side of each page for the addition of marginal notes or cross references by the Director. I happen to have had through my hands the individual reports received by more than one of our Directors of Sections, and I have been struck by the great amount of extra labour which is but too often thrown upon the Director of a Section by the varied character of the notes of observations sent to him. When such notes are contained in letters of all sizes, written on both sides of the paper, and often mixed up with other matter, one cannot wonder that the task of unearthing and digesting the facts is one which a Director is not greatly inclined to undertake. On the other hand, individual notes on sheets of uniform size can be readily classified, and after the preparation of the Director's reports they can be conveniently collected and preserved in pamphlet cases in our library for future reference. Altogether I would strongly urge the consideration of this point on our Directors of Sections.

I have now to deal with the third class of our Members, namely, those who are either non-observers or who, if they observe at all, are provided with a very limited instrumental equipment. This

is a very large and important class, and it may, as I have already hinted, be conveniently sub-divided into at least two sections, one comprising those who already possess a considerable knowledge of astronomy, and the other consisting of those who are more or less beginners in the study of our science. To both these sections our Association should be of considerable service, while both, on the other hand, can materially aid the objects which the Association has in view.

To our Members forming the first sub-division much really useful work is open. In the first place they may render valuable aid to our Observing Sections. Nominally, of course, our Sections should consist of actual observers, but as I have already pointed out, observations can only be estimated at their full value when carefully arranged and compared, and I see no real reason why the ranks of our Observing Sections should not include Members who, although not observers themselves, are competent to discuss and compare the observations of others. It has to be borne in mind, too, that such discussion of observations as I am here referring to should not be confined to the examination of new observations only; on the contrary, it should include comparisons with past published records, for it is only by such comparisons that the true lessons of many new observations can be learned. The questions of the periodicity of the changes in the markings on Jupiter is a case in point.

Such aid to the work of the Observing Sections as I am foreshadowing would also include the calculation of cometary and double star orbits; the preparation from the records of double star observations of lists of pairs appearing to demand special attention; the examination and comparison of records of variable stars; the examination of lunar photographs and their comparison with older charts and drawings; the comparison of old and new planetary observations, and much other work of a cognate kind. How valuable may be the aid to astronomical progress rendered by researches of this class, carried out by one who is not himself —or herself—an observer is admirably shown by the writings of one of our own Members, Miss Clerke, whose books and papers we all so greatly value. Altogether, I feel certain that the collaboration of competent non-observing Members would be welcomed cordially by the Directors of most of our Observing Sections.

Then, again, there are other directions in which the class of Members with whom I am now dealing can do useful work. Some may strike out original lines of mathematical or geometrical investigation, as has been done by Mr. Whitmell, whose papers contributed to our "Journal" aid us so much in realising aspects of the solar system regarded from other planets than our own; others may take up optical matters and assist in the perfecting of our telescopes and spectroscopes, as Mr. Thorpe, while still others may afford to our hard-working Editor much needed assistance in his preparation of those abstracts of foreign astronomical publications which form so valuable a feature in our "Journal." I have, however, I think, said enough to show that the fact of not possessing an observatory or instrumental equipment is no bar to the accomplishment by competent Members of work of real value to our Association and to astronomical science generally.

I have now finally to deal with the second section of the third of the three classes into which I have ventured to divide our Members. This Section, it may be remembered, consists of those who are commencing the study of astronomy. I will not call these Members "learners," because that is really not a distinctive term. An astronomer devoted to his science never ceases to be a "learner" however eminent he may become; and, in fact, with the growth of knowledge comes inevitably the growth of the conviction that great as has been the progress of astronomical discovery we have as yet only touched the fringe of that great science whose possibilities are as limitless as space itself. Using then, for the want of a better, the term "beginners" to denote the class of Members of which I am now speaking I wish before concluding this address—already I fear protracted to an undue length—to offer a few remarks on the manner in which I consider that the study of astronomy can be most advantageously commenced.

In the first place, however, let me comment briefly on certain complaints—for the most part very mildly expressed—which have from time to time reached me from beginners as to the character of the contents of our publications. These complaints assume that inasmuch as the promotion of the study of astronomy is one of the chief objects of our Association, that therefore our "Journal" should be devoted largely to the explanation of elementary astronomical facts. Now this is such an untenable —and I should have thought obviously untenable—assumption, that I should not have referred to it, had I not had evidence that it is somewhat widely held, but held, I believe, unthinkingly. The proper object of our "Journal" is not to afford elementary astronomical information, which can far better be obtained from text books, but to record progress and to supplement text books by keeping our Members fully informed with regard to new discoveries and current astronomical work. Such elementary information as beginners require is to be sought not in our "Journal" but in our library, while our "query box" affords a ready means of obtaining explanations on points which text books may not make clear.

I trust that the remarks which I am about to make on the commencement of the study of astronomy will not lead anyone to suppose that I in the least underrate the value of the numerous popular works on our science, or the admirably illustrated magazine articles dealing with astronomical subjects, of which so many have appeared during recent years. On the contrary, I believe such books and articles have done great good, and have, by the interest they arouse, caused many additions to be made to the ranks of amateur astronomers. But the beginner who, wishing to study astronomy, confines his attention solely to such writings as I have just referred to is much in the position of a man who thinks he can become a soldier by reading glowing accounts of hard won victories. Such a beginner, who has had his imagination stirred by the examination of beautifully reproduced photographs of comets, or nebulæ, or lunar views, is apt to experience more or less severe disappointment when he is shown these objects through a telescope of moderate size. Not having

had experience in observing, he misses much detail which even such an instrument can show, and realising how far what he sees falls short of what he had been led to expect, he is apt to jump to the conclusion that observational astronomy, at all events, offers few attractions to those who have not at command an expensive instrumental equipment.

Now this conclusion is an utter mistake, a fact which the beginner who approaches the study of astronomy in the proper spirit will soon recognise. It has to be borne in mind that, great as are the attractions of modern astro-physical research, the real basis of our science is that which is sometimes called by way of distinction "gravitational astronomy." It has further to be borne in mind that the earlier astronomers working with instruments of a very elementary kind obtained a considerable knowledge —which was in many respects really remarkable for its approximate accuracy—as to the motions of the heavenly bodies, and as to the phenomena presented by the chief members of our solar system. Now, what was done in the olden times can be done in the present day, and I wish to prominently direct the attention of beginners to the fact that by the employment of quite simple apparatus they may make observations which will bring home to them, in a way which mere reading can never do, a knowledge of many astronomical phenomena which they will find to be, not only of immediate interest, but of great value to them in their further studies.

What I wish to urge, therefore, is, that those commencing the study of astronomy should not be content with reading only, but should work in the open air, faithfully and systematically recording their observations, however elementary these may be. I lay great stress on this latter point, because unrecorded observations have, as a rule, little educational value. The mere fact of describing in writing any observation, however simple, which has been made is of immense assistance in securing completeness and accuracy. Of course, the country offers greater facilities than towns do for this out-of-door work, but there are few towns where access cannot be had to some convenient site giving a fairly clear horizon and sufficiently free from traffic to allow of star maps being referred to without serious inconvenience. Naturally the beginner's first endeavour will be to identify the brightest stars, and trace out approximately the confines of the various constellations. Continuing this study, he will gradually acquire a knowledge of the paths followed by the stars in their courses from rising to setting, and obtain a clear idea of the position of the apparent axis of this motion. As time goes on, he will further notice that the constellations he has identified set earlier and earlier each evening, and that other constellations previously unseen will come into view on the eastern horizon. Further, he will notice that the path followed by the moon in her course through the sky not only differs at different parts of a lunation, but varies for any given part of a lunation at different seasons of the year. As his knowledge of the sky progresses, he will be able to identify any bright planets which may be visible, and to observe their changes of position with regard to the adjacent stars, changes which he will do well to note in his sketch-book

for future reference and consideration. Now, the beginner who has learned these elementary facts by actual observation of the sky, and has subsequently, by the aid of his text-books, mastered the reasons for what he has observed, will have made a very fair start in the study of astronomy, and he will, I venture to think, have acquired a far keener interest in the motions of the heavenly bodies than he would have possessed if he had confined his attention solely to books, or if his open-air observations had not been of a systematic character. He will also find that by the aid of some very simple home-made instruments, such as a cross-staff, a rude form of transit instrument, and other similar appliances, he will be able to make observations which serve to still more impress upon his mind the facts he has been learning. Of course, such observations must be crude and wanting in accuracy, but they will, nevertheless, be found to serve a very useful educational purpose.*

To the beginner who has thus taken up the study of celestial motions, an endless number of problems will suggest themselves for examination, and it will be found that the solution of these problems will afford work which is not only of great immediate interest, but will lead to the acquirement of knowledge of considerable future value.

It has been often said that "Learners should not be ashamed to ask questions." This is quite true in a certain sense, and no beginner should be ashamed to acknowledge that he has much to learn. But the practice of asking questions is not one to be advocated, except within certain strict limits. The beginner who immediately he gets into a difficulty asks for aid to get out of it, is not likely to make any great progress. It is the battling with difficulties, the habit of regarding a problem from various points of view, and the practice of "getting at the bottom of things," which impresses truths and principles on the mind, and a few facts so learned are worth ten times the number acquired by the question and answer method.

The statement I have just made appears to me to apply with special force to the use of instruments. Many present have no doubt been struck, as I have, by the character of numerous queries respecting the use and adjustment of instruments which, from time to time, appear in print. These questions suggest the idea that those proposing them are of opinion that scientific instruments should be made on the "You-touch-the button-and-we-do-the-rest" principle, and that their employment should require no special knowledge on the part of the user. Now, this is a frame of mind which is much to be deprecated. Nothing is more essential to secure the best results with any instrument than a clear comprehension of the principles on which such instrument is constructed. It is only by the possession of such knowledge that the user of a telescope, a spectroscope, or other astronomical appliance can determine whether or not any defect in performance is due to

* Beginners desiring to take up the study of astronomy on the lines here advocated will derive considerable assistance from two American books recently published, viz., "A New Astronomy for Beginners," by Prof. David P. Todd, and "A Laboratory Manual in Astronomy," by one of our own Members, Miss Mary E. Byrd.

a radical fault in such instrument or to a comparatively trivial fault in adjustment. For this reason I would thoroughly urge beginners, when they take up actual observing, to study carefully the theory of any instrument they may employ, and make themselves familiar with its principles and construction. Were this more generally done, much disappointment and loss of time would be saved, and instrument makers would be spared many unjust complaints and much worry.

I am afraid that my remarks on the section of our Members which I have classed as "beginners," have run to an undesirable length, but it must be remembered that the "beginners" of to-day are those from which we shall at an early date expect work which will promote the interests and strengthen the position of our Association, and any suggestions which may aid in their training may thus possibly be regarded as excusable.

In conclusion, I may quote a passage from the works of Bacon, which was written to have a wide significance, but which appears to me to apply with peculiar force to the science to which we are all devoted. Says the great philosopher:—"Knowledge is not "a couch whereon to rest a searching and restless spirit; nor "a terrace for a wandering and variable mind to walk up and "down with a fair prospect; nor a tower of state for a proud "mind to raise itself upon; nor a fort or commanding ground "for strife and contention; nor a shop for profit or sale; but "a rich storehouse for the glory of the Creator and the relief "of man's estate."

Mr. Maunder was sure there was only one feeling amongst all the Members present, and that was one of very great gratitude to their President for the address he had just given them. They had been greatly indebted to Mr. Maw from the very foundation of this Association, for he had undertaken the charge of its finances from the first, and although, of course, the money side of an undertaking of this sort was not the highest, yet one thing was perfectly certain, that if such an association were not financially sound, its usefulness would very soon come to an end. Consequently, they were deeply indebted to Mr. Maw for having kept them from the beginning upon a sound financial basis. Mr. Maw had not only carried out the ordinary duties of a treasurer with extreme diligence and faithfulness, but had added a variety of other duties to it far more numerous than he (Mr. Maunder) could describe. Only those who had been behind the scenes could tell how much of the actual work of the Association had been done by Mr. Maw himself. It had been a rule amongst them from the beginning, when in any difficulty whatever, to go to Mr. Maw and have it cleared away. And now they had had from Mr. Maw, as their President that evening, a most helpful address upon the position and prospects of the Association, and he (Mr. Maunder) hoped that address, when it reached the hands of the Members, would be carefully read, and the advice contained in it taken heed of and adopted. They had had in the past nine years a most gratifying amount of success, but there was no reason why they should not have a great deal more in the future. Nor was there any reason why what many of them felt to be

somewhat weak places should not be strengthened, why their various Sections should not be doing a great deal more work even than they were doing, and why the membership should not develop much more even than it had in the past. If they paid good heed to the address which Mr. Maw had delivered, he thought very much of that would be seen in actual practice. Mr. Maunder concluded by moving that a very hearty vote of thanks be accorded to the President for his address.

The vote was heartily accorded.

The *President* in acknowledging the compliment said he had only done what all the other Members of the Council, the Secretaries, and the Directors of Sections had done. He thought that without any self-glorification he might say they had all worked very hard for the Association. Good work had been done by the Council right away from the beginning, and they had always worked together very harmoniously, which was a great point. They had all done their best for the Association, and he had certainly done no more than any one else.

Mr. Maunder read a paper by Mr. Cecil J. Dolmage on "The Apparent Enlargement of Heavenly Bodies when in the Neighbourhood of the Horizon."

Mr. Maunder said that some years ago a Belgian astronomer, M. Stroobant, made a number of experiments with pairs of electric lights in a large dome. He had a pair of electric lights put overhead, and another pair at the same distance from him against the wall, and then he had the two altered in distance until to him they seemed as if they were the same distance apart; then, measuring, he found that this same apparent expansion of objects looked at straight forward on the horizontal plane took place with regard to the electric lights as held with regard to the stars; the distance apart of the pair of lights before him seemed exaggerated, that of the pair above him seemed diminished. He regarded it, therefore, as purely and entirely a physiological effect, due to something connected with our ordinary upright stature, so that when looking straight ahead an object looked very much larger, at the same distance, than it did when overhead.

Mr. McCarthy remarked that the effect alluded to by Mr. Dolmage was one for which an explanation was reasonably asked. The only answer which it was possible to give at present was that they did not know. In order to obtain information on the subject the librarian of the Royal Astronomical Society had looked through a large number of articles which had appeared in the "English Mechanic." He found a series of suggestions to account for the apparent enlargements of these celestial objects on the horizon, and their corresponding diminution at the zenith. The suggestions made in some cases were that this was caused by the atmosphere, one writer endeavouring to show that the effect observed would be apparent, supposing the atmosphere surrounding the earth could be regarded as a huge crystal; in looking along the horizon they looked through more of it, and in looking to the zenith they looked through less. Of course care had been taken not to confuse this effect with that due to refraction. Another

group of writers pointed out that it had been suggested that the effect arose from a comparison with objects on the earth and seen against the sky. The complete refutation of that suggestion was arrived at by making the observation on the ocean, where the constellations still appeared wider apart and the moon and sun appeared larger when near the horizon and gradually diminished in size as they approached the zenith. It was also said that when they took a hollow tube and looked through it at the sun (or the moon) just after it had risen, its apparent magnitude sank to the ordinary magnitude of the sun when seen at the zenith. He tried this, and found that when he shut one eye and looked through the tube the moon always looked smaller; but if he viewed the object with one eye when it was at the zenith it looked smaller than if he used both. Consequently he took two tubes and looked at the moon carefully night after night with both eyes, and found the tubes made no difference whatever. The suggestion was that these tubes cut off the view of the surrounding objects and confined the vision to the moon when rising, and then, of course, the moon was sure to appear as it did at the zenith. He found that would not stand the test of so simple an experiment. He would suggest to all interested in the science of astronomy that a certain amount of attention should be given to this qnestion to see whether a satisfactory conclusion could not be arrived at with regard to it. If, however, the explanation suggested by Mr. Dolmage could be taken as sound, then the alteration in the position of the person observing, from standing up to lying down, would entirely overcome the difficulty. But that had been tried many times, and every attempt to alter the position had failed to remove the apparent difference. If the effect arose from the construction of the eye, then the atmosphere might be entirely removed without altering the effect, which, to say the least, was doubtful. He quite understood the suggestion that there was a wider vision taken in by the eye when looking towards an object on the horizon; but he had explained previously that a person altering his position found the object just as much enlarged or diminished in appearance whatever the position of the observer.

Mr. W. H. Wesley said Mr. Dolmage's explanation was somewhat similar to the well-known suggestion that the celestial vault does not appear to us as half a hollow sphere, but as an ellipsoid in form; so that it is apparently much nearer to us in the zenith than at the horizon. The question still remains: if it is due to an illusion of this kind, is the illusion optical or mental? He had tried the experiment of turning his head downwards, and looking at various objects in this position. They all appeared the same way upwards as they are in reality; but if he looked at a page of a book in the same way, that appeared to be upside down. This seemed to show that what at first sight seemed an optical illusion was really a mental one. He was inclined to think that the cause of the apparent difference referred to was mental rather than optical.

Mr. E. M. Nelson suggested that it would be a good plan to photograph the moon at the zenith and on the horizon. There

was no possibility of refraction cheating the photographic eye. Most of them were photographers, and everyone would have noticed in photographing a cliff with a lens 10-in. focus how very much dwarfed the cliff appeared in the negative when developed. He thought the phenomena were identical.

Mr. T. Clapton, referring to the suggestion as to photographing the moon or sun, said the result would be more accurately arrived at by measuring the disk with a sextant. That had been done over and over again, and the diameter was just the same whether the object was at the horizon or the zenith. It seemed to him that the whole thing was a matter of mental perspective. Let them measure 40 ft. on the ground and see how little it looked; yet that was a respectable height for a house.

The *President* remarked that the apparent enlargement was vertical as well as horizontal. Anyone watching the rising of Castor and Pollux could see this. That, he thought, was the most striking instance that existed in the sky.

Mr. Clapton said the fact remained that, measuring the angle with the sextant, it would be the same in every position, except that the upright angle would be affected by refraction.

Mr. L. B. Tappenden mentioned what he considered a cognate illustration. If a person went out of doors on a starry night, and fixed on a star which he assumed to be at an elevation of 45°, and afterwards took the measurement of the angle, he would find, as a rule, that the elevation was considerably less. If he took two stars which he thought to be at an elevation of 30° and 60°, he would find the 30° was considerably less, and that the 60° was also less, though not quite so much. He thought these mental illusions were very cognate.

The *President* said 60° was a most deceptive angle. Anything at 60° looked very much higher than it really was.

Mr. Maunder said the sun and moon had, of course, often been photographed at almost every conceivable altitude above the horizon, and the only difference in the diameter of the photographs was that due to refraction, the effect of which, of course, compared with the apparent difference now under discussion, was quite negligible. For instance, on the solar photographs taken at Greenwich, after correcting for the distance of the earth from the sun, and for refraction, they got just the same diameter in midwinter as in midsummer. The photographic plate, therefore, knew nothing whatever of this enlargement near the horizon. It struck him that M. Stroobant's explanation might be tested by the simple experiment of looking at the rising or setting moon when lying on one's back with the head towards the moon. If the suggestion of that gentleman were correct, it would seem that the rising moon, when so viewed, should appear to be of the same diameter as it ordinarily appeared to be at or near the zenith. M. Stroobant's experiment seemed to show that the effect had nothing to do with the atmosphere, because he conducted the experiment in a building, and had his electric lights, those on

the level and those which were overhead, both at the same distance from him.

The *President* remarked that the discussion was an interesting one, but he did not think they had got much nearer the explanation than they were before. With regard to refraction, he might point out that the effect of refraction would be to tend to decrease the distance between any objects situated one above the other, as was the case with Castor and Pollux, and the lower star would be raised more than the other.

Mr. Petrie read a paper by Mr. Edwin Holmes, being a sketch of the life and work of John Bird, who, in the early part of this century, visited nearly every town in the kingdom as a lecturer on astronomy.

The *President* said they were much indebted to Mr. Holmes for this interesting piece of history. Mr. Holmes had rescued it from pages which doubtless would never have been seen by many of the Members.

The meeting adjourned at 7 p.m.

Reports of the Branches.

NORTH-WESTERN BRANCH (MANCHESTER).

The Ninth Session of this Branch was opened on October 11, with a lecture by Miss Gertrude Bacon, Member of the British Astronomical Association, entitled "The Indian Eclipse and its Lessons."

In the unavoidable absence of the President, Prof. T. H. Core, M.A., the chair was occupied by Mr. S. Okell, and there was a large attendance of Members and friends. Miss Bacon had a specially hearty welcome, her name being already familiar to the audience, some of whom had now the pleasure of renewing an acquaintance made at Vadsö in August 1896.

The story of the Indian Expedition and of the Eclipse, as viewed at Buxar, on 22nd January 1898, was told by Miss Bacon in a racy and fluent manner. The lecture, both in its scientific and more popular aspects, illustrated by numerous lantern slides, was much enjoyed by the audience, and additional interest was given by a series of views taken in the course of a balloon excursion by the lecturer, along with her father, from the grounds of the Crystal Palace.

At the conclusion of the address a hearty vote of thanks was accorded to Miss Bacon.

WEST OF SCOTLAND BRANCH (GLASGOW).

The Fifth Annual General Meeting of this Branch was held in the Athenæum on Friday, 20th October 1899. The chair was taken by the retiring President, Mr. J. Dansken at 8 p.m. The minutes of the meeting held on 19th May 1899 were read and approved. The Report of the Council on the work of the Session was read by Mr. Brand, and, on the motion of Mr. Dansken, seconded by Mr. Main, was approved by those present. The report of the Treasurer was next read by Mr. Orr, and was approved on the motion of Mr. Dansken, seconded by Mr. A. W. Stewart. At this point Mr. Mackintosh rose to a point of order; he challenged the accuracy of a line printed beneath the ballot paper which stated that "this paper is prepared in accordance with "Rule VIII. of the Branch constitution," as certain gentlemen were not eligible for re-election under that rule; he reserved power to deal with the matter at a later stage. Mr. W. L. Walker supported Mr. Mackintosh. Mr. F. L. Grant explained that this objection had been foreseen by the Council, and requested that, in order to save explanation, the Council minute should be read. The President objected to this on the ground that it was possible that the names complained of by Mr. Mackintosh might not be in the definite list of council as declared by the scrutineer. Mr. A. W. Stewart then formally moved, and Mr. Grant seconded, that the Minute of the Council meeting held on 29th September 1899 be read, and after some discussion the minute was read. The scrutineer, Mr. R. Robertson, then explained that as Mr. Cairney was not present, the duty of examining the ballot papers had fallen wholly upon him, and he declared the following members had received the highest votes for the respective offices.

President -	The Rev. E. B. Kirk.
Vice-Presidents	J. Dansken; H. MacEwen; W. S. Stewart.
Secretaries -	J. Main; W. L. Walker.
Treasurer -	J. Mollison.
Council - -	D. Hunter; M. Tullock; T. Carlaw; Major Cassells; J. Neilson.

Mr. A. W. Stewart moved that the election be considered null and void on account of an irregularity in the ballot paper, and the motion was seconded by Mr. Orr.

Mr. Dansken moved, and Mr. McKissock seconded, that the names receiving the highest number of votes be elected to the respective offices, and that no exception be taken to the said names on account of ineligibility. The amendment was accepted by the meeting. Mr. Orr protested against the decision, pointing out that instead of endorsing the present irregularity, it would be easy to put the matter right by appointing to the posts eligible persons chosen from among the more experienced Members of the Branch, but he was ruled out of order, and, after some further discussion, the Rev. E. B. Kirk took the chair and delivered a short address. Mr. A. W. Stewart moved, and Mr. J. Dansken seconded, that it be remitted to the new council to draw up a set of new rules for the Branch, and that the Council report upon this point with the

utmost despatch. This was agreed to by those present. The scrutineer next requested and obtained authorisation to destroy the ballot papers. The usual votes of thanks closed the meeting.

EAST OF SCOTLAND BRANCH (EDINBURGH).

The first Meeting of this Branch for the current Session was held at No. 5, St. Andrew Square, Edinburgh, on the evening of Saturday, 28th October.

After the election of office-bearers, a discussion took place as to the desirability of acquiring a lantern for the use of the Branch, and it was agreed to purchase one. It was also decided, subject to the consent of the parent Society being obtained, to admit ladies and gentlemen, on payment of the ordinary Branch subscription, to the Meetings of the Branch, but who would not necessarily be Members of the Association.

A lecture, illustrated by limelight views, was then given by the new President, Mr. J. Turner, M.A., B.Sc., his subject being the 1898 eclipse. Mr. Turner referred to the parties organised by the Association for the observation of this eclipse in India, and to the valuable work done by the Members in spectroscopy, photography, and drawing. He dealt at some length with the spectroscopic aspects of the eclipse, describing the various instruments used, and referred to Mr. Evershed's valuable work in photographing so successfully the spectrum of the reversing layer. This observer's ingenious suggestion to observe the reversing layer throughout the whole of totality from the edge of the shadow path was illustrated by means of a blackboard drawing. Mr. Turner also pointed out that the discrepancy between former drawings and photographs was now cleared up, thanks to Mrs. Maunder's unique photographs of the coronal extension. The speaker further described in detail the various parts of the sun's surroundings, and discussed the problems in connexion with them, pointing out what had been done towards their solution at the recent eclipse.

The lecture was illustrated by a set of slides kindly lent by Mr. E. Walter Maunder.

After the thanks of the Meeting had been accorded to Mr. Turner for his very interesting address, several Members made reference to the forthcoming Leonid meteor shower, and Mr. Jas. Rankine showed a projection of the almost total eclipse of the moon in December.

The office-bearers for the present Session are as follows:—

President	-	Mr. J. Turner, M.A., B.Sc.
Treasurer	-	Mr. J. McDougal Field.
Secretary	-	Mr. Charles F. Smith, 108, Findhorn Place, Edinburgh.
Council	-	Mr. Edward Downes, Mrs. Jessie Pagan, Dr. John Connel, M.A., F.R.C.P.E., Mr. W. M. Baxter, Rev. P. Hately Waddell, B.D., F.R.A.S., Mr. W. Forgan, Dr. W. G. Black, F.R.C.S.E.

VICTORIA BRANCH (MELBOURNE).

Members of this Branch met together on 7th September, Prof. Kernot, M.C.E., in the Chair. After the usual formal business and nomination and election of new Members had been dealt with, Mr. P. Baracchi, F.R.A.S., exhibited on the screen a large number of lantern slides prepared from a series of lunar photographs taken at the Paris Observatory. These beautiful delineations of lunar topography, perhaps the best which have yet been produced, were greatly admired, and the interest of Members in viewing the pictures was increased by the varied information given by the Lecturer in connexion with the several objects exhibited.

The next Monthly Meeting fell on 5th October, Mr. E. F. J. Love, M.A., F.C.P.S., in the Chair.

"Variable Stars" formed the subject of a very interesting paper by Mr. R. J. A Barnard, M.A., in which the chief characteristics of the several types of variables, as learned by observation with the naked eye, the telescope, the spectroscope, and photography, were minutely described. Large diagrams of the light curves of several several of the more notable variables were exhibited, and the arguments for and against the various causes suggested for the fluctuations in light were carefully discussed by the Lecturer.

Mr. Baracchi reminded Members that the observation of variables was of a kind which was well within the scope of the of the careful amateur, and afforded to such a wide field for future discovery.

Reports of the Directors of the Observing Sections.

Report of the Saturn Section.

Owing to the small altitude of Saturn above the horizon during its late period of visibility, there is little in the way of observation that is worth reporting. Mr. Maw and Mr. Kempthorne write me that they have been able to do nothing for the above reason, and Mr. Stanley Williams has failed similarly. I am sorry that Mr. Davis reports he has been obliged to give up telescopic observation.

Dr. Smart has noticed in a marked manner the optical illusion of the sky between the ring and the planet appearing darker than that outside the ring. He has seen the slight dusky bands N. and S. of the planet's equator, and a slight shading near the pole. In the rings he has noticed no unusual appearance, and the crape ring has been plain across the planet.

Mr. H. J. Townshend seems to have been favoured with better opportunities than others. He writes that the crape ring seemed narrower than usual, which is probably explained by the planet's S. declination, and also what is more interesting, namely, that on the 15th and 17th of June last, he saw Cassini's division of

the ring all round, and clear of, *i.e.*, below, the N. pole of the planet.

Mr. Townshend says, and, as far as I can see, with truth, that if his seeing is correct the polar diameter of the planet must be more compressed than Prof. Barnard's measure, 16″·31, put it. Mr. Townshend adds, that Cassini's division was tangential to the N. pole of Saturn, and on July 10, 1898—as he saw it—and the elevation of the earth above the plane of the rings was then only 25° 43′. Whereas on the 15th July 1899, the elevation of the earth above the plane of the rings was 26° 40′, so that, if Cassini's division was tangential to the N. pole of Saturn on 10th July 1898, it should be seen below it on 15th June 1899. Is it possible that the rings are not placed symmetrically in the plane of the planet's equator?

The shadow of the ball upon the rings was beautifully seen to fall evenly all around the N. pole on both days, 15th and 17th June 1899. Mr. Townshend also adds, that he invariably saw the equatorial belts as triple lines.

Mr. Townsend has had some correspondence with Mr. Moore, of Hatfield, near Doncaster, who has taken much trouble in calculating the position of the inner edge of the outer ring, with reference to the limb of the planet. Mr. Moore remarks that the inner diameter of the outer ring is, according to Prof. Barnard, 35″·046 at Saturn's mean distance, which multiplied by ·454, the sine of 27°, the maximum elevation of the earth above the plane of the rings in 1899 = 18″·91, which is less than the polar diameter given by Prof. Barnard as 16″·241, therefore, the inner edge of the ring in question ought to cut the planet. Mr. Moore subsequently points out that taking 17″·800 and 16″·241 as the equatorial and polar diameter of Saturn respectively, as given by Prof. Barnard, the apparent polar diameter when seen from the earth when at an altitude of 27° above the plane of the ring becomes 16″·561, which rather increases the difficulty. For the ring, with the earth at the above altitude, to touch the disk of the planet with the last named diameter it must have a diameter at its inner edge of 36″·48.

Mr. Moore quotes the following measures, which are all less than the last-mentioned value. Maw, 36″·40 (maximum); Proctor 34″·63 (minimum); Meyer, 34″·98; A. Hall, 34″·95; Barnard, 34″·86; Dyson, 34″·74; Lewis, 34″·91; Barnard, 35″·08. Either, therefore, the measures are wrong or the seeing of Cassini's division clear of or touching the planet's disk is illusory, or the planet and ring are not symmetrically placed. Mr. Moore points out that Mr. Proctor noticed that drawings do not correspond with appearances calculated from tables.

The Rev. A. H. Foulkes, writing from Kandia, says that on May 18 1899 at 10.15 to 11.15 p.m. he noticed the crape ring on the following side to be very bright and sparkling and narrow, the preceding edge was uneven. The colour light steel-grey. At this time the other side of the ring was very dull and of normal appearance.

Mr. A. Cottam and Mr. H. MacEwen say that owing to the low altitude of the planet they have been able to make no observations, and Mr. Griffiths writes to the same effect.

Some few months ago Mr. Whitmell wrote to me on an investigation of the form of the edge of the planet's shadow on the ring. His results were so interesting that my friend Mr. L. Cumming and I made some experiments with a model of Saturn and his ring in the presence of an electric arc for the purpose of investigating the shadow curve practically in confirmation of Mr. Whitmell's figures, with the result that I have asked him to write a paper on the subject for this report. The question is one of sphero-conic sections, and the appearance of the shadow curve to us the projection on a plan, normal to the eye, of a section of an elliptic cylinder, by a sphere.

The Members of this Section are now, so far as I can ascertain by replies to my communications, Messrs. Green, Maw, Cottam, Holmes, Townshend, MacEwen, Rev. A. H. Foulkes, Messrs. Kempthorne, Stanley-Williams, Davis, Dr. Smart, Messrs. Whitmell, Griffiths, Mee, and myself. I shall be glad to receive any additions or alterations necessary.

G. M. SEABROKE.

Papers communicated to the Association.

A Lecturer on Astronomy.

It would be an interesting inquiry how much the progress and the popularisation of science often owes to men of lowly station, small opportunities, scanty education, and meagre acquirements, who obtain but little renown during life, and whose very names are forgotten in a few years after their death. Sometimes a man of this kind has been able to increase knowledge generally, although he was neither an observer nor a theorist, and never enlarged the boundaries of science in any direction. But continually engaged in relating by lecturing what he had learnt from others, he acquires a facility in communicating it again, and perhaps is the more successful in his special line, because his standpoint is low, and he is not raised to the unapproachable height of those who are upon the summit of the pyramid of human knowledge. And he may conduce to the progress of knowledge, also indirectly, by stirring up interest and thus causing study and inquiry on the part of men of larger powers than himself. He may scatter seed both in individuals and in public bodies which may germinate and result in a harvest of which he had no conception or expectation.

A man of this kind appears to have been John Bird, who lived in the earlier part of this century, but about whom I have only been able to learn such particulars as are contained in an old volume of the "Leisure Hour." He was born in Lincolnshire, and brought up as a carpenter. He appears to have resided in Berkshire as a young man, and while there engaged in erecting a staircase in 1814 he attracted the attention of his employer, who was also interested in scientific matters. Bird had made a "Tellurian," having no instruction but such as he could get from

"an old print on a leaf of Ferguson's Astronomy." There is no description of this Tellurian, excepting that it was perfect in all respects, (which we may doubt, without thereby depreciating his work; for all such contrivances I have seen fall far short of deserving such an adjective) mathematically divided, and explained zodiacal position, and solar and sidereal time.

It is related his fellow workmen made fun of him, but as he found their superiors encouraged him he was not troubled much at their chaffing him with setting up as a magician.

However, aided by the advice and money of his employer, he worked night and day at the construction of an orrery. The result is styled "a noble and valuable piece of mechanism, "designed to give motion to the spheres in illustration of celestial "phenomena." But when it came to representing the planets, he appears to have been at a loss until his friend suggested square tin tubes perforated at the face and illuminated by little oil lamps within and fixed on the arms of the orrery. Apparently the orrery was not seen by his audience, but merely employed to throw images upon a screen, as it is said they "produced on a calico medium the much-desired transparencies."

Bird was then announced to deliver a lecture in the Town Hall of the place, and to exhibit his apparatus. He had to borrow the suit of black in which he lectured, and such a lecture being a novelty, he had a large audience. He met with success, and from that moment he became a lecturer on astronomy.

For upwards of 30 years he followed this career, and visited nearly every town in the kingdom. At first he tramped from town to town with his apparatus on his back, often starting the same night he delivered his lecture, for the next fixture on his list. Later, he travelled in a respectable carriage drawn by one horse. He carried an optical lantern, a calico screen with the signs of the zodiac painted round it (a hint for the embellishment of our own screen, if you choose to take it), a box of slides, and his array of tin stars and planets.

He was a stout, obese man, and in his later years of venerable appearance. He had a large, good-humoured face, was well clad, and eminently respectable, and apparently everywhere well received. His delivery was monotonous and mechanical, and his voice unmusical. His science was very elementary, and manner and language unrefined. But he had a retentive memory, natural readiness, and an inventive mind, and had the further advantage of delivering all his lectures extempore.

One would have expected him to be enthusiastic, but we are told he was not, and his principal interest was a business one, or as the writer puts it, "to huckster the stars for his daily "bread."

He must have had considerable repute in his day, for he was engaged to lecture by the Universities of Oxford and Cambridge, and secured at both "all the success he could have wished," and obtained from the heads of houses "complimentary testimonials "little short of the usual university titles." Possibly the present establishments of those universities for the study of astronomy owe something of their present position to the influence of the lectures of this almost forgotten mechanician.

Whatever his deficiencies, his abilities were such as brought him upon familiar terms with people of very high rank. He became astronomical teacher to the Marquis of Douro, afterwards the second Duke of Wellington, and attended regularly at Strathfieldsaye. He also wrote a poem in honour of the Great Duke, which secured from his Grace the present of a new pair of globes. He sometimes lectured at Brighton before the Royal Family, and usually in Lent was commanded to wait upon the Duke of Cumberland at Kew Palace, where he appears to have been quite at his ease, especially with Prince George and the Duchess.

Very many of the sundials scattered about the country upon lawns were erected by or under the superintendence of Mr. Bird, and it is a satisfaction to know that in his combined professions of sundial maker, lecturer, and teacher of the globes he was financially successful enough for him to have been in good circumstances during his latter years. He died in 1840.

I fear few of us realise what the acquisition of astronomical knowledge by a working man meant 80 or 90 years ago, when there were few books, and those costly. How few one can somewhat realise by noticing how few of the books on their own shelves date so far back—there were no free libraries, or astronomical societies, within his reach, and instruments were enormously more costly, and less efficient than now. The larger part of the population were unable to write, or even read, and school meant little to the lower classes, the principal teaching instrument being neither a book nor a slate, but a cane, and even those whose parents sent them to school had almost universally to change it for the workshop at the age of 9 or 10, and often earlier. Afterwards there was seldom time, opportunity, or inclination to attend to learning, or the cultivation of the mind. If, occasionally, a man like Mr. John Bird undertook and succeeded in such an enterprise, under such conditions, and even to become the tutor of kings and princes, and more honourable still (considering the probable ignorance of kings and princes as regards astronomy), to become an acceptable lecturer at two universities, I think he deserves that his memory should not altogether perish.

Mr. Bird, apparently, may never have possessed an astronomical telescope, or entered an observatory. His observations were upon wooden orbits, and tin stars and planets, which troubled him not with vagaries of definition. He never found any "canals" on Mars or Venus, or elongated the satellites of Jupiter. He never divided double stars one-tenth of a second apart with 6½-in. Gregorians, or other telescopes of that aperture, as three anonymous observers have done of late. He may not have framed any theory of the colour of Martian vegetation, or of the varying intellectual capacities of the inhabitants of that and other planets, but he did such work as was within his scope—such as lay next his hands—and enlarged the ideas of many thousands about the phenomena of the heavens, who, but for him, would have had no conception that the twinkling lights of the midnight sky were of any more importance than the moving disks upon his calico screen produced by Mr. Bird for their instruction.

EDWIN HOLMES.

On the Apparent Enlargement of Heavenly Bodies when in the Neighbourhood of the Horizon.

By CECIL G. DOLMAGE, M.A., LL.D., F.R.A.S.

This is a question which, though generally considered as inexplicable, has nevertheless brought forth from time to time many attempted explanations. To the number of these I am about to add yet another, which, perhaps, after all, may not be original. However, I give it in good faith as such, not having met with it so far in my own reading. But if I err in this, and it turns out to be ancient, I ask for correction from my readers.

The explanation of the phenomenon which generally seems to meet with most favour is this: that we are apt to estimate the apparent size of celestial bodies (the sun or moon, for instance) by comparing them with terrestrial objects in the same field of view, a comparison easiest made, of course, when the bodies in question are low down in the sky; and that since *we know* that these terrestrial objects are, *in reality*, much *greater* than as we see them, we are thus apt to unconsciously exaggerate the size of the celestial bodies by a species of sympathy.

The apparent enlargement referred to is not by any means confined to the cases of the sun or moon, but is most noticeable in that of stars situated a little distance apart, this distance being apparently much increased when they are in the neighbourhood of the horizon. Take, for instance, Capella and the large star near it, viz., β Aurigæ; these two appear very much further apart when low down than when high up in the sky. This apparent widening out is also well observable during the early evenings of the present time of the year (October), in the setting of that magnificent triangle of stars of which Arcturus occupies the lowest angle. No one who is familiar with the appearance of this great triangle when high up in the sky can fail to be struck with the very evident and increasing distortion of its relative parts in their gradual descent towards the horizon. Fairly equilateral when high up in the sky, it becomes in the course of its descent towards the horizon more and more isosceles, being drawn downwards in the direction of Arcturus. At the present season also may be watched with interest the gradual closing together of the larger stars in the constellations of Perseus and Andromeda as they mount upward toward the zenith. What can be the reason of these appearances, which are known to be illusory, since micrometric measurements fail to explain the matter in any way?

The explanation which I desire to submit is as follows:—Let an observer look up towards the zenith and consider the expanse of sky presented to his gaze. He will notice that it contains *practically no trace of curvature*, in fact, it will appear to him as flat as the roof of a room. This is, evidently, because his field of view is not extensive enough as to include any appreciable portion of the dip of sky towards the horizon. In fact, had he lain upon his back all his life and known nothing at all about the horizon, he would never consider the expanse of sky above him as anything other than a plane. Next, let him lower his eyes gradually towards the horizon. In accordance as he does this he will notice that, on account of the dip of the sky in front and, particularly, on either side of him coming more and more into the

field of view, the plane heaven which he has just been looking at will little by little assume the appearance of concavity, this appearance of concavity rapidly increasing, and finally reaching its maximum when the gaze is directed to a point on the horizon.

Now, let us see what effect this change will have upon a definite portion of the sky as seen by an observer. It must be quite clear to anyone, who for a moment considers the matter, that the distance between markings upon a plane *elastic* surface will be increased in proportion as the plane is bodily hollowed out so as to assume a concave shape, *the boundaries of the plane being always preserved at the same initial distance from each other*. To illustrate:—Imagine two posts erected at a fixed distance from each other, and a large sheet of india-rubber stretched tightly from one to the other. Now let a person stand in front of this sheet, and about its centre make (say) a couple of marks a slight distance apart. If the sheet then be hollowed out so as to form a curve concave towards the experimenter, it would be very clear to the latter that, in consequence of the stretching of the india-rubber, the total area of the surface of the sheet would increase in proportion as the concavity became greater, and that, therefore, the distance between the marks would increase similarly. An even better illustration might be found in the consideration of the increasing expansion of (say) printed letters, or markings, on the surface of an elastic balloon, consequent upon its gradual inflation, only the illustration is here inverted, as the markings must be considered for our purpose as viewed from a point well within the body of the balloon. But the general idea remains the same.

This, then, gives the clue to what takes place when an observer views the heaven. The eye looking zenithwards perforce considers the expanse as a plane; then, as the gaze is lowered, and the dip around the sky towards the horizon comes increasingly into view, the eye *unconsciously* considers this plane as gradually becoming more and more concave towards it; therefore, the total area of the *field of view* of sky (regarded chiefly in its lateral extent), and, in consequence, the area of any definite portion of it, is considered as having enlarged.

A short time ago I received a practical corroboration of my views as stated above. I happened to enter a room brilliantly lighted by electricity, one of whose windows faced the moon which had then just risen. In consequence of the illumination around me, my distance from the plate-glass of the window, and the general obscurity outside, I was quite unable to distinguish either earth or sky or their meeting place, the horizon. The moon, therefore, appeared as if set in a sheet of inky blackness. I then remembered that it had only just risen, and was in consequence rather surprised not to see it enlarged as usual. For, indeed, it seemed just of that size which one usually associated with it when seen in mid-heaven. But miracles do not happen nowadays. Seen in the open air, the accustomed enlargement was perfectly apparent; and, along with it, were plainly visible the dark earth and lighter circumambient horizon, and, consequent upon the latter, *that marked concavity of sky* in which, as it seems to me, lies the solution of the pheromenon.

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Notices of the Association.

The ordinary Meetings of the Session will be held on 1899, November 29, December 27; 1900, January 31, February 28, March 28, April 25, May 30, and June 27.

New Member of the Association.

ELECTED 25TH OCTOBER 1899.

Miss EMILY GOOCH, Enderlie, Torquay.

Candidates for Election as Members of the Association.

29th NOVEMBER 1899.

REV. J. G. BENSON,
Mill Hill Road, Derby.
Proposer—J. J. Vezey. *Seconder*—Thos. Frid Maunder.

MISS J. E. A. BROWN,
Further Barton, Cirencester.
Proposer—E. Walter Maunder. *Seconder*—W. H. Maw

W. E. BUCHANAN,
Care of Messrs. Grindlay, Groom & Co., Bombay, India.
Proposer—A. Younghusband. *Seconder*—W. J. Carson.

JOHN CHARLES CLARET,
11, Hartham Road, Bruce Grove.
Proposer—William W. Sidey. *Seconder*—Arthur E. Fisk.

EDWARD THOMAS CROKE,
"Innisfallen," Worthing.
Proposer—Augustus R. Schutz. *Seconder*—Thos. Frid Maunder.

FRANCIS JOHN GARRARD,
High Holme Road, Louth, Lincolnshire.
Proposer—George H. Davies. *Seconder*—John Wm. East.

REV. JOHN LAIDLAW, B.D.,
Free Church Manse, Meethill, Perthshire.
Proposer—John Turner. *Seconder*—Charles F. Smith.

JAMES ROBERTSON JACK,
8, Rose Villas, Romberg Road, Tooting.
Proposer—D. Lyall Main. *Seconder*—James Groves.

REV. SYDNEY ERNEST MARTIN,
1, West View, West Malvern.
Proposer—Alfred Watson. *Seconder*—E. J. Cope.

RICHARD PONSONBY MAXWELL,
Foreign Office.
Proposer—W. H. St. Q. Gage. *Seconder*—T. H. E. C. Espin.

Samuel Reeves,
"Homeside," Boldmere Road, Wylde Green, nr. Birmingham.
Proposer—Charles Parker. *Seconder*—Herbert Holmes.

Richard Frind Roberts, A.C.A.,
15, Dingwall Road, Croydon, Surrey.
Proposer—Ebenezer Prout. *Seconder*—Thomas Lighton.

Reginald Appleby Wilson,
Westfield, Armley, Leeds.
Proposer—Washington Teasdale. *Seconder*—W. D. Barbour.

New South Wales Branch.

New Member of the Association.

Elected 1st October 1899.

Dr. E. J. Frieman, 16, Maerton Street, Stanmore, Sydney, N.S.W.

Victoria Branch.

New Members of the Association.

Elected 7th September 1879.

Richard Sillery Sugars, Commercial Bank, Collins Street, Melbourne.

Elected 5th October 1899.

Joseph Dorgan, 85, Barkley Street, Carlton, near Melbourne.

Francis Joseph Smart, 11, Elizabeth Street, Melbourne.

Notes.

The late Mr. N. E. Green.—It is with great sorrow that we have to record the death, on November 10th, of Mr. N. E. Green, F.R.A.S., President of this Association in the years 1896–98. We hope to give in the next number of the "Journal" a full notice and a portrait of Mr. Green.

Comet Notes.—The following elements of Comet 1899 *e* (Giacobini) are by S. K. Winther from observations on October 1, 9, 22. (A.N. 3600).

$$T = 1899, \text{ Sept. } 13{\cdot}9178. \quad \text{Berlin M.T.}$$

$$\left.\begin{aligned} \omega &= 10^\circ\ 9'\ 54'' \\ \Omega &= 272\ 16\ 12 \\ i &= 77\ \ 3\ \ 8 \end{aligned}\right\} 1899{\cdot}0.$$

$$\log q = 0{\cdot}25116.$$

Ephemeris for Berlin, Midnight.

Date.	R.A.	N. Dec.	Date.	R.A.	N. Dec.
	h m s	° ′		h m s	° ′
Nov. 24 -	17 54 12	10 34	Dec. 6 -	18 14 24	13 56
28 -	18 0 52	11 40	10 -	18 21 17	15 5
Dec. 2 -	18 7 36	12 47	14 -	18 28 11	16 16

Brightness 0·50 on November 24, 0·39 on December 14, that at discovery being taken as unity.

A note in "Nature," for October 5, p. 551, referred to the three comets discovered by Giacobini as one and the same comet. This is, of course, an error. They are all distinct and separate bodies.

Herr Zwiers has sent a postcard to **Obs.**, for November, stating that he has received nine observations of Holmes' Comet from Mr. Perrine, and five from Mr. Aitken. They were made with the 36-inch at the Lick Observatory between June 10 and September 9. They indicate that the mean anomaly in Herr Zwiers' connected elements requires correction by 8″. The comet is very faint, and only visible in the most powerful instruments.

Ephemeris for Greenwich Noon. (**A.N.**, 3595.)

Date.	R.A.	N. Dec.	Date.	R.A.	N. Dec.
	h m s	° ′		h m s	° ′
Nov. 20 -	2 16 32	48 1	Dec. 14 -	2 4 28	44 42
26 -	2 11 36	47 17	20 -	2 4 43	43 50
Dec. 2 -	2 7 53	46 28	26 -	2 6 10	43 0
8 -	2 5 30	45 35	Jan. 1 -	2 8 43	42 14

The brightness reached a maximum about October 15, when it was 1·8 times that at re-discovery. On December 26 it will have sunk again to that at re-discovery.

Tempel's Second Periodic Comet was observed by Signor Cerulli at Teramo on October 2, the corrections required by Schulhof's ephemeris being $-$ 1^s·9 in RA, + 3″ in December. It had a nucleus of the 14th magnitude.

Mr. John Grigg has sent a series of observations of this comet, made at Thames, New Zealand, in September.

M.N., LIX., No. 10 contains observations of this comet made at Grahamstown by Major Eddie. On August 15 it was well-defined, with a central condensation. On August 24 the nucleus was 2′ in diameter, surrounded by a faint coma, and the tail could be traced for 16′; a dark rift was discernible in it.

Minor Planet Notes.—**A.N.** 3597 contains a new determination of the orbit of (433) Eros, by Hans Osten. About 220 observations are employed, extending from 1898, August 14 to 1899, March 17, but the photographs made in 1894 and 1896 have not been utilised.

Epoch and osculation 1898, October 1·0. Berlin M.T.

$$\begin{aligned}
M &= 238^\circ\ 39'\ 44''\cdot 6 \pm 15''\cdot 8\\
\omega &= 177\ \ 39\ \ 21\ \cdot 0 \pm 15\ \cdot 2\\
\Omega &= 303\ \ 31\ \ 53\ \cdot 4 \pm \ \ 2\ \cdot 6\\
i &= \ \ 10\ \ 49\ \ 34\ \cdot 0 \pm \ \ 0\ \cdot 5\\
\phi &= \ \ 12\ \ 52\ \ 18\ \cdot 3 \pm \ \ 2\ \cdot 6\\
\mu &= 2015''\cdot 343 \pm 0''\cdot 073.
\end{aligned}$$

A planet, EQ, discovered in October, proves not to be new, but identical with (161) Athor.

Six new planets ER, ES, ET, EU, EV, EW, were discovered by Wolf and Schwassmann at Heidelberg on October 27, 27, 27, 31, 31, November 4 respectively. EV was at first thought to be identical with (214) Aschera, but this identity is now considered to be improbable.

Astronomical Publications.

THE SUN.—M. J. Guillaume gives his observations of the sun made at Lyons during the first quarter of 1899. The spots were greatly diminished, there being 12 days of observation without any. The diminution of the number of groups was to be chiefly seen in the northern hemisphere, where only four were noted as compared with 13 in the previous quarter. One spot in southern latitude 8° was visible to the naked eye in March. The number of faculæ was slightly augmented in the southern hemisphere and diminished in the northern. The total faculous area was, however, greatly diminished, being 41·0 millionths instead of 60·9 millionths. (C.R., 1899, September 25.)

In the same number M. Ch. André compares the time of contact of partial eclipses of the sun from measures of the length of the common chord and from direct observation. The accordance of the results makes it worth while to use the former method. (C.R., 1899, September 25.)

THEORY OF THE MOTION OF THE MOON. *P. H. Cowell.*—Of all numerical calculations in celestial mechanics, the problem of the motion of the moon is the most tedious, and the lines on which it is being attacked by Prof. Brown, following the method suggested by Dr. Hill, by far the best. It happens that the moon is so close to the earth that the disturbing action of the sun is never very large, and hence we conclude that the moon will not for a time get very far from the ellipse that it would describe in the absence of the sun. The action of the sun is, however, not wholly oscillatory in its effects, and the result is that no fixed ellipse will continue to approximately represent the moon's path. The difficulty was generally got over by considering an ellipse rotating in a convenient manner. This idea overcame the difficulty of making tables; but as under no conditions, admitting a physical interpretation, could the moon describe a rotating ellipse, it did not materially advance the solution of the problem of the moon's motion. Dr. Hill proposed to abandon the rotating ellipse

as an intermediary orbit, and substitute another curve, called the variation curve, to play the same part, and which is a curve that the moon could traverse if the conditions were slightly modified. The moon oscillates about this curve in four distinct ways, two oscillations being due to the measurable but varying distance of the sun, while two are free oscillations for which no cause can be assigned. The lunar theory is reduced, then, to a calculation of oscillations about a state of steady motion, and differs only in being more laborious from problems with which every student of advanced dynamics is familiar. (**Obs.**, October.)

THE "SEAS" OF THE MOON,—WHAT ARE THEY? *J. G. O. Tepper.*—The perfect visibility of the lunar "seas" at full moon and their disappearance in very oblique light shows that their dark appearance is due to their colour, and not to shadows caused by irregularity of surface. Assuming that the moon once supported animal and vegetable life, it is shown that all the elements (with the exception of carbon) forming these organisms, as well as those constituting the mould of the soil, would gradually be appropriated by the lunar crust. Carbon, on account of its weak affinities to any of the common gases at high temperature, would remain uncombined and be left probably in the form of dust. Wafted by the more and more decreasing air currents to the lee of gentle declivities this dust would finally be deposited upon the great low-lying plains where the opposing currents counterbalanced each other. The "seas" of the moon, therefore, may be large areas covered by carbonaceous dust, the last remains of the former vegetable and animal organisms of our satellite. (**Kn.**, November 1899.)

MARS.—Herr Ernest Hartwig gives from observations with the Repsold heliometer at Gottingen the flattening at the poles of Mars as 1/96. (**A.N.**, 3594.)

Herr Brenner remarks on the Juvisy observations of **Mars** given in **A.N.**, No. 3581. (**A.N.**, No. 3593.)

JUPITER.—Observations are given of the Opposition 1899 by M. J. Comas Sola, Herr Ph. Fauth, and Mr. Stanley Williams. The first two give charts of their observations, and M. Sola points out the different rates of speed of the different spots. (**A.N.**, No. 3596.)

THE GEGENSCHEIN. *T. W. Backhouse.*—Comparing the counterglow with the reflection from blades of grass, it is pointed out that the glow round the shadow of one's head is visible upon other objects, such as ordinary broken soil, and must be due to the increased reflection of light through that part being more directly opposite the sun. If the irregular particles of soil are capable of showing a striking counterglow, it may be easily conceived that particles of meteoric matter may be capable of the same. The absence of the shadow is simply accounted for by assuming so great an extension of the meteoric matter that the distance reached by the earth's shadow is relatively short and unimportant. (**Obs.**, October.)

THE NOVEMBER METEORS OF 1899. *Edward. C. Pickering.* —Directions are given for intending observers of the shower. The most useful observations that can be made by amateurs are those to determine the number of meteors visible per hour. Observations are particularly needed at hours when they cannot be made at the observatories of Europe and America. Photographs of the shower may be made in two ways. By leaving the camera at rest, or by attaching it to an equatorial telescope moved by clockwork. The most rapid plates are best, and should be changed once an hour and the times recorded. The full aperture of the lens should be used. The value of the results will be much increased if similar photographs can be obtained by a second camera from 10 to 40 miles distant N. or S. of the first. (**Kn.**, November 1899.)

METEORS.—M. Camille Flammarion communicates some very full observations of the Perseids, made in 1899 at Juvisy by MM. Antoniadi and Mathieu. A chart of the shooting stars and their radiant is given. (**C.R.**, 1899, September 11.)

Observations of the Lyrids of 1899 are given by A. A. Nijland and H. F. van Lummel in **A.N.**, No. 3598; of the Leonids of 1893 by A. A. Nijland in **A.N.**, No. 3598; of the Leonids of 1898 by E. Weiss in **A.N.**, No. 3593.

M. J. Comas Sola works out the path of a bolide ten times brighter than Venus of 1899, August 24. Its relative velocity was 24 km. per second, and its absolute 50 km. Its orbit was strongly hyperbolic. A red bolide on August 28 had a very similar path. (**C.R.**, 1899, October 2.)

THE LIFE OF A STAR. *T. J. J. See.*—In reply to Prof. Perry, it is pointed out that the symbol K in Prof. See's formula $T = \frac{K}{R}$ is a constant, different for each body, and not the same for the whole universe. In a paper to be presented to the S. Louis Academy of Sciences, it is shown that the only hypothesis underlying the investigations is that of convective equilibrium, and that whilst the law is of the utmost generality for masses composed of one kind of gas, the only modification necessity for a heterogeneous body, made of interpenetrating globes of different gases, is the introduction of a factor $(1 + \beta t)$, in the numerator on the right hand side, where β is a small secular co-efficient and t the time. An elementary investigation of the law is added. (**Nat.**, September 28.)

NOVA SAGITTARII.—"Harvard Circular, No. 46," gives the place of this star, discovered April 1898, as $\alpha = 18^h 56^m 12^s\cdot 83$, $\delta = -13° 18' 12''\cdot 98$ (1900). The measures were made on enlargements from photographic plates, and the accuracy is equal to that given by the best meridian observations. (**Nat.**, October 26.)

PHOTOGRAPH OF NEBULÆ SURROUNDING THE STAR D.M., No. 1841 MONOCEROTIS. *Dr. Isaac Roberts.*—The nebulæ shown in the photograph are assumed to be new to science, as they are not referred to in the catalogues. Taken with the 20-in. reflector

with an exposure of $2^h\ 47^m$, the photograph shows the brighter nebula to be of a floculent character with some faint star-like condensations, and containing a "keyhole" greatly resembling that in the η Argûs nebula. (**Kn.**, November 1899.)

THE SPECTRUM OF β CYGNI. *A. M. Clerke.*—When the contrasted stars of β Cygni were examined by Sir William and Lady Huggins in 1897, the spectra gave evidence of a signal diversity in constitution. In the fifth mag. "Sapphire" component, the hydrogen series appeared with no less emphasis, relatively to brightness, than in Vega, while the golden primary showed itself as of pronounced solar type. That the smaller star should have progressed more slowly than the large is perplexing, yet the same relation appears to be almost universally prevalent among tinted double stars. The photographed spectra do not explain the vivid colouring of β Cygni, resembling as they do those of any two stars of the second and first types respectively; but in the case of the blue component, a set of dark bands, cutting out a proportion of its yellow and orange rays, have been visually observed, and they fully account for its chromatic peculiarity. This is shared only by compound objects, there being no solitary blue star. The spectrum of the primary star is included by Miss Maury among those of "composite" type, and there is good ground for the suspicion that composite rays really emanate from a compound source, even where visual proof of duplicity is absent. (**Obs.** November.)

THE NEW STAR.—Herr Seeliger compares the observation of the new star discovered by Prof. Pickering in the neighbourhood of the Milky Way with previous novæ. He also compares them to meteor showers. (**A.N.**, No. 3598.)

THE ORION NEBULA.—Herr Scheiner remarks on the technical and photographic details of Prof. Keeler's photometric and photographic investigation of the Orion Nebula. (**A.N.**, No. 3593.)

PARALLAX.—Prof. W. Schur finds in **A.N.**, No. 3590, the parallax of a star near 61 Cygni. It was one of the reference stars for the parallax of 61 Cygni, and was of mag. $7^m \cdot 8$, lying in R.A. $20^h\ 55^m\ 20^s$ and Dec. $+ 37^\circ\ 32' \cdot 5$. This star had no parallax as compared with 61 Cygni, and therefore should have a parallax of $0'' \cdot 63$.

In **A.N.**, No. 3593, Osten Bergstrand finds parallaxes for Σ 1516 A and A O_2 11677 of $+ 0'' \cdot 080 \pm 0'' \cdot 011$ and $+ 0'' \cdot 192 \pm 0'' 013$ respectively.

ON THE DISTRIBUTION OF THE VARIOUS CHEMICAL GROUPS OF STARS I., II. *Sir Norman Lockyer, K.C.B., F.R.S.* (*A Lecture to Working Men.*)—Four groups are considered arranged in order of temperature as gaseous, proto-metallic, meteoric stars, and stars with fluted spectra. The Herschels showed that the number of stars visible in a given field increases gradually from the poles of the Milky Way to its plane, whilst the labours of Sir John Herschel and Gould demonstrated the existence of another belt of 500 of the brightest stars, including Sirius,

Aldebaran, with those in Orion, Centaurus, Scorpio, and Lyra, inclined at angle of 25° to the Milky Way, and crossing it at the Southern Cross and at Cassiopeia. It has been shown by Dunér, Pickering, McClean, and Campbell that planetary nebulæ and bright-line stars tend to condense in the Milky Way, as also the fainter proto-metallic stars. The brighter proto-metallic and the metallic stars with great proper motion, as well as the carbon fluting stars, are not so condensed, but the metallic stars with small proper motion, and therefore probably the most distant, have been found by Kapteyn to be collected in the Milky Way. For stars with metallic flutings the information is uncertain. New stars are attributed to collisions between a previously existing but unrecorded nebula, and a stream of meteorites rushing through it at, perhaps, 500 miles a second. These also appear almost exclusively in the Milky Way, and it is found generally that those classes which congregate in the Milky Way are at great distances from us. (**Nat.**, October 26, November 2.)

IS THE STELLAR UNIVERSE FINITE? *Gavin J. Burns.*—Having, in a previous paper, shown that there are reasons for supposing that the stars thin out as we recede from the solar system, four possible hypotheses are given to account for this conclusion:—(1) the absorption of light by the luminiferous ether; (2) by a gas filling inter-stellar space; (3) by cosmical dust; and (4) an actual decrease in stellar density. The first two are dismissed as unwarranted by observation, and the third, though probable, is negatived by the fact that the cosmical dust must have long ago been swept up by the stars themselves. By the fourth hypothesis, therefore, we are driven to conclude that the stellar universe is finite. We can only escape this conclusion by supposing the visible universe to be bounded by clouds of cosmical dust which conceal everything beyond, a view for which there is no foundation. The real solution of the difficulties presented by a finite universe may be of a metaphysical character. (**Kn.**, November 1899.)

STELLAR PHOTOMETRY.—The meridian photometer, with which recent observations have been made at the Harvard Observatory, consists of a pair of similar telescopes placed horizontally side by side. By an arrangement of prisms the image of a close polar star (λ Ursæ Minoris) used as a standard, and the image of a star passing the meridian, are viewed at once by the same eyepiece. By rotating a Nicol prism the images viewed can be equalised, and by the position of the prism the relative light of the two stars is determined. In this way it is possible to determine the accurate photometric relation of stars, but the standard of magnitudes so determined depends on the adopted magnitudes of the comparison star. (**Obs.**, November.)

PRECESSION TABLES.—Dr. Downing has compiled a volume of tables which give precessions corresponding to Newcomb's value of the constant. They are constructed for 1910, but may be used with facility for at least ten years before and after that date. (**Nat.**, September 28.)

Bradley's Observations at Kew. *W. T. Lynn.*—Now that Kew Palace is open to the public, it is probable that many more persons than heretofore will see the spot where Bradley made (in conjunction with Samuel Molyneux, to whom the house and instrument belonged), the first observations of α Draconis, which led to his great discoveries, first of aberration and afterwards of nutation. Although the house where the observations were made was pulled down in 1803, there is no doubt that the exact spot is marked by a sun-dial on a pedestal with a suitable inscription, which was erected by order of William IV. in 1832. (**Obs.**, October.)

The Melbourne Observatory.—The thirty-third report by Mr. P. Barrachi, covers the period from 1898, July 1, to 1899, February 28. With the 8-inch transit circle, 1,571 observations have been made in R.A., and 1,017 in N.P.D. for clock corrections, latitude determination, catalogue stars for reduction of astrographic plates, and special zodiac stars in connexion with Dr. Gill's heliometer observations of the major planets in opposition. The plates for the catalogue are now complete, and 387 have been passed for the chart. The measurement is proceeding rather slowly, and the filar micrometer is preferred to Prof. Turner's scale, the probable errors being $0''\cdot 1$ for the former, and $0''\cdot 5$ for the latter. Photographic registration of magnetic elements has been continued and absolute determinations have been made five times. The photo-heliograph has been employed for sun pictures, and 264 pairs of cloud photographs have been taken with cameras at different points round the observatory. (**Nat.**, October 5.)

Strassbourg Observatory.—The annual publication contains the reductions of star observations made during 1882–88, with miscellaneous results to 1893. The individual observations are followed by three catalogues containing 254, 858, and 368 stars respectively. Three appendices deal with heliometer measures of the partial solar eclipses of 1890, 1891, 1893, with the form of the pivots of the meridian circle and with the compilation of precession respectively. (**Nat.**, October 26.)

Modern Geodesy in France. *Col. Bassot.*—In 1866 a trigonometrical junction was effected with England, and later Capt. Perrier, an officer who had been engaged in this work, noticed, when stationed on the mountain of Oran, the visibility of certain summits of the Sierra Nevada, in Spain. It became, therefore, possible to connect godesically Algeria and Spain; and the meridian of France, already welded to the English triangulation, could be prolonged into Africa, thus stretching from the Shetland Isles to Lagouat. This is the programme that has been realised since 1870, and, together with the regular triangulation of Algeria and Tunis, forms the contribution of France to modern geodesy. (**Obs.**, November.)

Biela's Comet.—The discovery of this comet was reported from Santiago, Chile, at the end of October, but no confirmation has been obtained of the report, and no credence is to be attached to it.

Variable Stars.

Star.	Maximum.		Minimum.		References.
	Date.	Mag.	Date.	Mag.	
R Bootis	1899, June 4	7·23	—	—	A.J., 113.
V Bootis	„ May 10	8·02	—	—	„ 113.
R Camelopardi	($m - m$ = 296d.)	—	1899, Sept. 26	13·6	E.M., 291.
U Cancri	1899, April 7	12·4	—	—	A.J., 113.
U Canis Minoris A	„ Feb. 6	9·27	—	—	„ 113.
„ *B*	„ April 16	8·66	—	—	„ 113.
R Canum Venat.	„ April 3	8·0	—	—	„ 113.
R Comæ	„ July 31	8·88	—	—	„ 113.
R Corvi	—	—	1899, May 8	12·0	„ 113.
T Draconis	„ Aug. 16	8·0	($M - M$ = 410d.)	—	E.M., 185.
S Herculis	„ Sept. 21	6·4	—	—	„ 291.
T Hydræ	„ April 24	8·02	—	—	A.J., 113.
S Leonis	„ April 29	10·30	—	—	„ 113.
W Leonis	„ Oct. 26	—	—	—	„ 113.
V Libræ	—	—	1899, July 2	13·3	„ 113.
U Puppis	„ April 18	9·2	—	—	„ 113.
S Virginis	„ July 14	7·09	—	—	„ 113.
T Virginis	„ June 2	8·38	—	—	„ 113.
U Virginis, A	„ April 5	7·91	—	—	„ 113.
„ B	„ April 28	6·8	—	—	„ 113.
Y Virginis, A	„ May 12	8·72	—	—	„ 113.
„ B	„ May 27	8·45	—	—	„ 113.
Z Virginis	„ Sept. 12	—	—	—	„ 113.
RR Virginis	„ June 30	11·37	—	—	„ 113.
RS Virginis	„ Mar. 17	8·1	—	—	„ 113.
RT Virginis	„ Apr. 7	8·12	—	—	„ 113.
RU Virginis	„ Jan. 6	—	—	—	„ 113.

Maxima and Minima of Long Period Variables, (P.A., 435.)

MAXIMA.

Star.	Mag.	Dec.	Star.	Mag.	Dec.
W Cassiopeiæ	8·6	14	*R Orionis*	8·7	17
U Andromedæ	8·9	25	*R Leporis*	6·7	30
U Eridani	8·5	21	*T Leporis*	8·1	7
T Camelopard.	7·0	14	*U Aurigæ*	8·6	17

Star.	Mag.	Dec.	Star.	Mag.	Dec.
R Cancri	6·0	23	*S Cygni*	8·8 ?	19
V Hydræ	6·7	19	*RR Capricorni*	9	31
S Leonis	9·0	32	*V Capricorni*	9	2
Y Virginis	9	17	*S Cephei*	7·4	4
U Virginis	8	2	*R Piscis Aust.*	8·5	25
T Centauri	5·9	7	*Z Aquarii*	8·2	16
RZ Scorpii	6	19	*V Cephei*	6·2	17
RV Sagittarii	8·2	18	*W Ceti*	8·4	11

MINIMA.

R Trianguli	11·7	7	*R Leonis*	10	12
R Persei	13·5	16	*R Virginis*	11	22
V Tauri	<13·5	15	*S Libræ*	<13	16
R Aurigæ	12·7	31	*χ Cygni*	13·5	24
V Aurigæ	<11·5	9	*RT Cygni*	11	11
S Canis Minoris	12	25			

Minima of the Variable Stars of the Algol Type.
(Given to the nearest hour G.M.T.)
(P.A., 435.)

U Cephei.			*S Cancri.*			*Algol.*			*R Canis Maj.* Every 8th Min. $P = 1^d\, 3^h \cdot 3$		
	d	h		d	h		d	h		d	h
Nov.	3	13	Nov.	2	23	Nov.	7	23	Nov.	9	11
,,	8	13	,,	12	10	,,	10	20	,,	18	13
,,	13	13	,,	21	22	,,	13	17	,,	27	15
,,	18	12				,,	16	14			
,,	23	12	*W Delphini.*			,,	19	11			
,,	28	12		d	h	,,	30	22			
			Nov.	18	16						
			,,	23	11						
			,,	28	6						

λ Tauri.			*DM + 12°·3557.*			*S Velorum.*			*DM + 45°·3062*		
	d	h		d	h		d	h		d	h
Nov.	1	17	Nov.	3	10	Nov.	2	20	Nov.	1	18
,,	5	16	,,	8	18	,,	8	18	,,	6	8
,,	9	15	,,	11	10	,,	14	17	,,	10	22
,,	13	14	,,	16	18	,,	20	15	,,	15	11
,,	17	12	,,	19	10				,,	20	1
,,	21	11	,,	24	18				,,	24	15
,,	25	10	,,	27	11				,,	29	5
,,	29	9									

o Ceti.—When seen on July 19 this star was about 7^m. From that date to August 20, it advanced slowly, and came to a halt; it then fell slowly, till, when last seen, September 7, it had reached 5^m. (Kn., 253.)

SS Cygni.—Flanery gives ephemerides of this star on various dates between July 19, 1898, and July 12, 1899, and a record of his observations from August 22 to September 7, 1899 (Kn., 226, 253). The July and August maxima were well observed, the dates assigned to the former being July 14, 10, 11, 11, by Daniel, Flanery, Parkhurst, and Sperra, respectively; and to the latter,

August 2, 15, 10, by Flanery, Parkhurst, and Sperra, respectively. (**P.A.**, 437.)

R Leonis.—The maximum probably occurred May 21, though predicted for June 26. Flanery gives his observations from February 19 to July 9. (**Kn.**, 253.)

U Orionis.—The same observer gives the magnitudes of this star from January 29 to May 9. (**Kn.**, 226.)

New Variable.—This star, which was suspected of variability by Kapteyn, has been observed at the Cape. Its place is $15^h\ 32^m\ 42^s, -54°\ 54'{\cdot}4$ (1875). The observations give a period of $12{\cdot}68^d$, and the epoch 1897, August $27^d{\cdot}25$ G.M.T. The range of magnitude is from 8·7 to 9·3. (**A.J.**, 112.)

Gore continues (**Kn.**, 200, 233) his articles on suspected variables. He gives historical notices of the following:—Andromedæ, ε Pegasi, 83 Ursæ Majoris, Z Virginis, 65 Ophiuchi, 37 Leonis Minoris, ξ Piscis Australis, η Crateris, θ Eridani, companions of Algol, ζ Ursæ Majoris, γ Virginis, β Geminorum, Bm. II. 16 Leporis, σ Orionis, * 1° S. of *g* Virginis, * 40′ *s.f.* 53 Virginis, Heis 67 Draconis, 7 Aquarii, λ Geminorum, 31 Geminorum, β Herculis, ξ Herculis, and small stars in the neighbourhood of σ Coronæ, σ Aræ, σ Capricorni.

THE ROTATION OF THE SUN.—Herr C. A. Schutz Steinheil, in a publication from the Lund Observatory, gives the results of a complete discussion of Dunér's spectroscopic determinations made between 1887, June 3, and 1889, May 18. The results are that a point on the equator moves with velocity $2{\cdot}054 \pm {\cdot}0042$ kilometres per second about an axis inclined to that of the ecliptic $18°{\cdot}12 \pm {\cdot}25$, the longitude of the ascending node being $28°{\cdot}00 \pm {\cdot}50$. (**Nat.**, October 12.)

Additions to the Library.

Klein.—Star Atlas.
Proctor.—New Star Atlas.
—— Other Suns than Ours.
Newcomb.—Popular Astronomy.
Nasmyth and Carpenter.—The Moon.
Galilei.—Sidereal Messenger, translated by Carlos.
Ball.—Starland.
Ledger.—The Sun, its Planets and their Satellites.
English Mechanic, Vol. LXIX.
Astronomische Nachrichten, Vol. CXLIX.
Crossley, &c.—Corrections to Handbook of Double Stars.
Lebon.—Histoire Abrégée de l'Astronomie.
Adelaide Observatory.—Meteorological Observations in 1896.
Rousdon Observatory.—Observations, 1882–85.
—— Variable Star Notes, Nos. 2–5.
Peck.—Observations of S Ursæ Majoris, 1886–92.
—— Observations of T Ursæ Majoris and S Cephei.
Strassburg.—Kaiserlichen Universitäts-Sternwarte Annalen, Band II.
Vienna.—K.K. Universitäts-Sternwarte Annalen, Band XIII.

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REPORT OF THE MEETING OF THE ASSOCIATION, HELD ON NOVEMBER 29, 1899, AT SION COLLEGE, EMBANKMENT.

W. H. MAW, F.R.A.S., *President*, in the Chair.

J. G. PETRIE, F.R.A.S., *Secretary*.

The *Secretary* read the Minutes of the last Ordinary Meeting, which were confirmed.

The *President* said that before the regular business was proceeded with he had an announcement to make, and he did so with much regret. Since the previous Meeting they had lost, by death, their late President, Mr. N. E. Green. As many present doubtless knew, Mr. Green was one of the founders of this Association; he had served on the Council as Vice-President, as Director of the Saturn Section, and was his (Mr. Maw's) immediate predecessor in the chair. In all these offices he fulfilled his duties in a most conscientious manner, and not only so, but he fulfilled them with an unfailing courtesy which endeared him to them all. As an astronomer, Mr. Green was a representative of the very best type of amateur observer. He never sought to make sensational discoveries, but he was a keen and accurate observer, and recorded all his observations with the utmost care, and with the greatest skill. His training as an artist enabled him to do this in a way with which the Members of this Association were well acquainted. It would, he (the President) thought, be admitted that Mr. Green's planetary drawings had become classic. He had had an opportunity himself of examining many of the originals, and could say without hesitation that none of the reproductions in any way did justice to the beauty of the original work. For fidelity to detail and delicate rendering of

colour and shading, these drawings had rarely been equalled—they certainly had never been surpassed. At the Council Meeting that afternoon a resolution was passed containing a vote of condolence to Mrs. Green and her family. It read as follows:—
"The Council and Members of the British Astronomical Asso-
"ciation have learned, with the greatest regret, of the death of
"Mr. Nathaniel E. Green, formerly President of the Association,
"and Director of the Saturn Section, and they desire to express
"their deep sense of the loss which the Association and astronomy
"have sustained thereby, and to offer their sincere sympathy to
"his widow and family in their bereavement." In order that the Members of the Association generally might join in the vote, it was proposed to add the words "and Members" after the word "Council," and he would, therefore, put to the Meeting a resolution that such addition should be made.

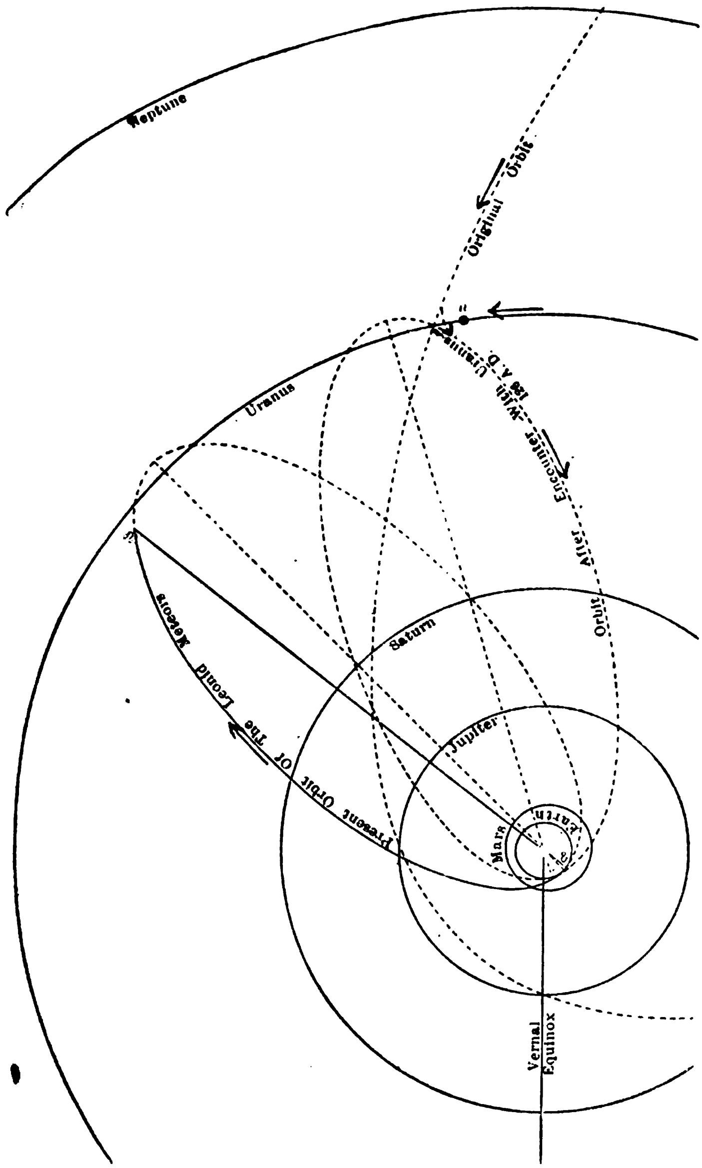
The resolution was passed unanimously.

The names of eight Candidates for admission were read, and passed for suspension, and the election by the Council of 15 new Members was confirmed.

An interim Report of the Meteoric Section, from the Director, dealing with the November Leonids of 1899, was first presented.

Dr. Johnstone Stoney said that while we have to regret the absence of the great Leonid display for which we had hoped, it is some consolation that the risk of what has actually happened was foreseen, and that we are in a position to say with considerable confidence what it is that has kept the earth from this year receiving one of the great Leonid showers. It is due to the new position into which the meteoric orbit has been shifted since 1866, owing to the quite abnormal amount of the perturbations to which the meteors in the dense part of the stream have been exposed since that year. We are able to follow with accuracy what has happened to the meteors which occupy one special position in the great procession, namely, that portion of the stream through which the earth passed in 1866. The late Prof. Adams succeeded in determining what was at that time the form, the size, and the position of the immense elliptic orbit round the sun along which these meteors travel. Each of the meteors occupies 33¼ years in performing its circuit round this great elliptic orbit, which we may call Adams' orbit. Meanwhile the orbit itself is constantly undergoing slight changes in its form, size, and position, owing to the perturbing forces, which are incessantly attracting the meteors towards the planets of the Solar System as well as towards the sun. Fortunately, the alterations which Adams' orbit has in consequence undergone within the last thirty-three years have been accurately followed by the skilled computers of the "Nautical Almanac," acting under Dr. Downing's instructions and supervision, and it has thus been ascertained that the changes of the orbit due to perturbations have been of unusual amount during this revolution, chiefly because the great planet Saturn approached close to the meteors upon their outward journey, and Jupiter while they were returning. From these computations we now know fully what has happened to these meteors. The amount by which their orbit has been shifted,

though of entirely abnormal amount during this revolution, is nevertheless too small to be easily made visible upon a diagram.



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To make it visible, imagine a sheet of diagram paper of the size and shape of a large hall-door, so large as to be 8 feet in height, Upon it draw the largest ellipse which it can take, 8 feet long and

of the full width of the door. This will represent the meteoric orbit upon a scale such that every inch of the diagram represents 20,000,000 of miles in nature. A point $4\frac{1}{2}$-in. above the lowest point of the ellipse will represent the position of the sun; and if we draw round this point a small circle about the size of a small dessert-plate, it will represent upon the same scale the earth's orbit. In the diagram, the two orbits have to be drawn upon the same plane; but in nature they lie in two intersecting planes which are inclined to one another at an angle of 16°. In 1866 the great elliptic orbit accurately intersected the earth's orbit at one point. The ellipse has since shifted its position by an amount which, on the diagram, would be represented by about $\frac{1}{16}$-in., but which, in nature, is 1,300,000 miles; so that at six o'clock on the morning of Thursday, November 16, when the earth came closest to the meteoric orbit, the nearest point on that orbit lay inside the earth's orbit at the above distance from the earth—that is, it was more than five times as far off as the moon. Thus we know that one point in the ortho-stream—the dense part of the Leonid stream—was at that distance from us. Now the ortho-stream is known, from the duration of the great meteoric showers, to be about 100,000 miles thick; but from dynamical considerations it is known to be of immensely greater width, and we entertained the hope that its width might have carried part of it 1,300,000 miles farther from the sun than the point in it whose position we have been able to determine. What the non-appearance of a great shower this year establishes is that, wide as is the ortho-stream, it has not extended far enough beyond the point whose position is known, through which the earth passed in 1866, and which this year lay at the above-mentioned distance inside the earth's orbit. But there is a further matter of much interest. Though the earth has not passed in any considerable degree within the ribbon-shaped stream, the observations recorded in Mr. Denning's report seem to give reason to hope that we may have passed through the extreme outward fringe of it. He mentions that one observer counted a considerable number of Leonids in an opening in the clouds early on the morning of the 16th November. If other observers more favourably circumstanced confirm this observation, and have recorded the hour at which the maximum occurred, it will furnish information of real value. In fact, we know from dynamical considerations that the stream has the ribbon shape spoken of above. We also know that 17 centuries ago the width of this ribbon lay in a direction perpendicular to the earth's path; and we know that perturbations have since tended to shift it a very little round in the retrograde direction; but we cannot learn from theory what the amount of the shift has been. We shall, however, be able to determine it by observation, if the earth this year passed close to the edge of the ortho-stream, and if the time of the maximum of the somewhat augmented display consequent upon this has been adequately observed.

The *President* asked Dr. Downing to give the meeting what information he possessed with reference to the shower for next year.

Dr. Downing said he need not detain the Meeting for many minutes, as he merely wished to state the results at which he had arrived in looking forward to the conditions that would obtain on November 15 next year. Unfortunately those conditions were still worse than those which prevailed on November 15, just passed. That portion of the dense part of the stream, which would reach the node next November, and whose position they had been able to calculate, instead of being about 1¼ million miles, would be about 1¾ million miles nearer the sun than the earth would be at the time, so that he was afraid that there was less chance than on the present occasion of there being any large display. The time when the phenomenon ought to be visible was 3 o'clock in the afternoon of November 15 next, assuming that the ribbon of which Dr. Stoney had spoken lay in the direction from the sun to the earth. If, however, it were inclined, as they found reason to believe, the display would be earlier, and would come some time in the night between November 14 and 15. Unless the distribution of matter round the dense part of the swarm at that part of the orbit was different from what it was at the part which we had just passed through, he was afraid there was very little chance of their being any such display as was seen in 1866. It was regrettable that the present generation should not have the opportunity of seeing such a display as that about which they had been reading all their lives. He was afraid that the next time the phenomenon came round, 33 years hence, many of them would not be in a position to look for it, so that this was the only time for very many of this generation, and it was really very unfortunate that it had turned out to be such a bad chance.

Capt. Steele said he had some doubts whether the stream really existed. If it were a stream of any size and any dimensions, it should reflect light, and that reflected light should be shown on a photograph, if not seen by our eyes. Until he saw that a photograph had shown that this stream reflected light, he could not believe it really existed, but rather that these meteors were simply the creatures of our earth.

Mr. G. J. Newbegin said he had a feeling that we had lost the Leonids, and he would explain why. Since 1866, it was quite possible that the orbit of the Leonids might have been very much retarded and contracted by the action and influence of our major planets, such as Saturn and Jupiter. If such should be the case, the orbit had assumed lesser dimensions than it had had in past times, and in future the earth would miss the Leonid stream altogether. He only hoped he might be wrong, but that was the feeling he had about the matter.

Capt. Noble thought it was to be regretted that the researches of Dr. Downing and Dr. Stoney were not made a little more public than they were. Up to the last moment they had many newspapers and magazines holding out hopes of something amazing in the shape of a display. There was no doubt there had been a great deal of penny-a-lining, as there always was on these occasions. He confessed that having read much that was written, he himself was not particularly hopeful. "Blessed," said a wise man, "is he who expecteth nothing, for he shall not be

disappointed." He (the speaker) did not know that he expected anything. He was up on the morning of the 15th from midnight until two o'clock, and he thought he saw five meteors; but whether they were all Leonids or not he would be very sorry to say. When he said he expected nothing, he was bound to qualify that statement, for he was hardly in that condition. Perhaps his state of mind would be more accurately illustrated by the statement of the gentleman of the agricultural persuasion, who, when asked how much his pig weighed, replied, "Well, it did'nt weigh "as much as I expected it would—I always thought it wouldn't."

The *Rev. G. Castleden* thought they had had a rich harvest as a result of all the looking for the Leonids this time, in the tremendous interest which had been devoted to the matter, especially in such publications as the "Strand," the "Windsor," the "Standard," and the "Echo," and others. Although it might be said that those got most out of a matter who made much ado about it, he thought astronomy owed much of real interest to this agitation. His object in rising, however, was to ask a question in reference to two phenomena which he had noticed, the first on November 13, and the other last Sunday night. He referred to very remarkable sunsets—sunsets of a brilliant golden crimson with a green sky, reminding him of those splendid sunsets in 1883, which were attributed to the dust from the eruption of Krakatoa, and he had wondered whether the sunset of November 13 was sufficiently near to the time of dust scattered by the Leonids, and that of November 26, sufficiently near to the dust which might be scattered by the Andromedes to have any connexion with the phenomena to which he had referred.

The President wished to ask Dr. Stoney whether the prospect of being able to photograph the Leonids next year before their striking the earth's atmosphere was better or worse than it was this year. Dr. Roberts had, he understood, made an unsuccessful attempt this year to photograph the Leonids before they struck our atmosphere.

Dr. Downing thought that the present year was the best chance Dr. Roberts would have in that matter, and that it was quite hopeless next year. Dr. Roberts had attempted to take such a photograph on perfectly fine evenings, and had obtained no trace whatever of the Leonids.

Mr. Maunder read a précis of a paper on "Jupiter's Equatorial Current," by M. Comas Solà. The writer said, that on examining the results obtained during several years by several astronomers, we could not fail to be surprised by the rapid changes in speed of the equatorial spots as compared to that of spots resting on Jupiter's surface. In M. Solà's opinion the cause was certainly outside the planet, and was a satellite, or perhaps several satellites, invisible or small, very close to the primary, and with an angular velocity a little greater than that of the planet. The action of such satellites would be entirely on the equatorial region, and would be more ineffective on the lower strata of the atmosphere, where were the equatorial bands and the Great Red Spot, than on the highest.

Mr. C. T. Whitmell read two papers upon kindred subjects entitled respectively, "Tides for Jupiter," and "The Shadows of Jupiter's Satellites."

Mr. Crommellin said Mr. Whitmell had brought forward a very interesting point with regard to the change in the shape of these shadows. He (the speaker) believed Prof. Schaeberle noted something about these changes four or five years ago. It was very curious that they had attracted so little attention. Of course, seen from the sun, the shadow would always be the same shape as the satellite itself. It was only the fact that we saw these shadows at an angle different from that of the line of sight from the sun to the planet that enabled us to see the change at all, and, as Mr. Whitmell said, that angle never exceeded some 12° or so. It was certainly a point that observers might well look out for at the two quadratures of the planet, three months or so before and after opposition. The planet was then a good deal smaller than at opposition, and observation was rather more difficult, owing to the increased distance; but certainly it would be worth while to verify by careful observation these curious changes of shape. With regard to the question of tides referred to in M. Solà's paper, it seemed a very big order to require a new satellite—an unseen satellite—for these tides, and he (the speaker) thought M. Solà must have forgotten the extreme weakness of the gravitation force, which made it incredible that a satellite utterly invisible to us could produce such a striking effect by its action. The tidal action of an unseen satellite—a satellite too small for us to see—could scarcely be as great, in spite of the small distance, as that of the old four satellites. It would require many thousands of unseen satellites very near the planet. It seemed to him that these changes of rotation of different parts of Jupiter should be taken in conjunction with similar changes in the sun; there was probably a common cause for both. The different rotations at different latitudes of the sun had a very much wider relative range than those of Jupiter; but anyone who studied the different rotations of Jupiter should take the solar phenomena into account as well. He did not know whether M. Solà imagined several intramercurial planets to account for the changes on the sun, his theory, at any rate, would seem to require that.

Dr. Johnstone Stoney thought it would be of interest to mention that some 20 or 25 years ago, there was a paper published by the late Charles E. Burton,* who was an extremely accurate observer of this phenomenon—of the elongation of the shadows when Jupiter was in or near quadrature, and who came to the conclusion that the mere oblique direction from which we then view the planet does not account for the phenomenon, but that we must supplement that by some further operating cause, and that which Mr. Burton suggested was that the shadow penetrated obliquely, that is, obliquely as regards our point of view, down through an atmosphere of very great depth. The paper written by that

* Mr. Burton's paper is in the "Monthly Notices" of the Royal Astronomical Society for December 1874, Vol. 35, p. 65.

observer gives his estimate of the depth of the atmosphere which would account for the amount of elongation which he observed.

Mr. Washington Teasdale, who said he had made a great many experiments from time to time on the curious effects of photography, exhibited a slide showing the semi-occultation of the sun by a church steeple. This gave well-marked effects of reversal of image and irradiation, and in reply to questions by Mr. Thwaites said his exposures were made on Ilford ordinary plates, not backed. He hoped, when opportunity occurred to repeat his experiments with backed plates for comparison of results. He regarded the subject as one which should be followed up, and added that the exhibition of this slide might be a suggestion to some who cared to experiment.

The *President* announced that they had some lantern slides, prepared from photographs which had been taken by Prof. Keeler at the Lick Observatory by means of the 36-in. Crossley reflector. This reflector, it would be remembered, was originally made by Calver and purchased by Mr. Crossley from Dr. Common. After having been erected at Halifax, it was presented by Mr. Crossley to the Lick Observatory, where it had been used for photographing nebulæ and star clusters with most excellent results. Prof. Keeler was, he thought, to be heartily congratulated at the success he had attained. The photographs which were then shown upon the screen and described by Mr. Wesley were as follows: (1) Spiral Nebula in Canes Venatici, taken 1899, May 10, with an exposure of four hours; (2) Spiral Nebula in Ursa Major, taken 1899, June 8, exposure four hours; (3) Trifid Nebula in Sagittarius, taken 1899, July 6, exposure three hours; (4) Cluster M 13 in Hercules, taken 1899, July 13, exposure two hours; (5) Ring Nebula in Lyra, taken 1899, July 14, exposure ten minutes; (6) Dumb-bell Nebula in Vulpecula, taken 1899, July 13, expoeure three hours; (7) Great Nebula in Orion, taken 1898, December 11, exposure one hour.

The *President* was glad to announce that the Rev. J. M. Bacon and Miss Bacon were present. They were all heartily glad when they received the good news that Mr. and Miss Bacon had finished their adventurous journey without any further mishap than that which befell them. Mr. Bacon had kindly promised to give them an account of that journey, and they would certainly all value his remarks.

The *Rev. J. M. Bacon* first referred to the exaggerated reports which had been circulated with regard to the injury which he and his daughter sustained in their descent, and then proceeded to describe the journey, which was made on November 16 from Newbury, and which eventually terminated near Neath, in South Wales. Incidentally, he said, he took upon himself his full share of blame for what proved to be a risky journey involving them in the unprecedented predicament of being aloft for nearly 10 hours in a balloon that would not, and, in fact, could not, come down. They knew for certain the while, that it was travelling hour after hour towards the Atlantic (though they could not get a glimpse of the land over which they were passing), and in the end it came down of its own accord only a mile and a half short of the open sea. When it was arranged that he should make

observations of the Leonids on behalf of the "Times," he consulted their greatest authorities on the subject, Dr. Downing and Dr. Johnstone Stoney, and he was frankly told that if he would fulfil his commission properly he must have a balloon ready to start at any hour of either of the nights of Tuesday or Wednesday. He at once consulted Messrs. Spencer, the well-known aeronauts, who said the thing could certainly be done, but it would require a balloon that should be fitted with a solid or ripping valve, a valve that admitted of no leakage whatever, and no manipulation, so that it might stay in the air for many hours, and which, when once torn open, was torn open for good and all. All things being ready, he and his daughter made the ascent shortly after four o'clock on Thursday morning. At a height of 1,500 ft. they entered a canopy of cloud. It was a warm wet fog, the consequence being that before they could pierce it, the envelope of the balloon, which was a large one, became very heavily charged with condensed moisture. They had to throw out bag after bag to get it to pierce the cloud, and they then got into the cold upper current. This chilled the gas in the balloon, and rendered it less buoyant, and so sent it down again. Time after time they went up a little way, only to find the balloon descending again. They threw out as many as seven bags in 20 minutes, which meant about 3 cwt., and then it was that their balloon seemed to have got its level and meant to keep there. There was no more delicate balance in existence than a poised balloon. They were then able to take observations. For the first hour they counted as many as seven meteors, none of them very striking, with one exception. One left a very lasting trail. In the second hour they were more frequent; but those that broke away upwards at that time (5 a.m.) were lost to view from a balloon such as this, for although they saw the radiant, the huge expanse of the balloon above them hid the trails that rose up towards the zenith. Most remarkable of all was the bursting of three or four meteors away from Orion in a manner which he had never before witnessed. However, there were other things to look for. The most remarkable phenomenon was the colour of the stars. Sirius was seen flashing, not in gleams of white, but in several hues of blue. Still more remarkable was the colour of the moon. He had seen it the purest white; on this occasion its colour was the dullest copper. There was no lack of definition. The purity of the atmosphere above was most remarkable. More noteworthy still was the dawn. It broke distinctly green at 5.58, and then all in a moment it developed into a great flood of light. He had never seen a sunrise anything like so sudden, not even in India. It had been stated in the papers that he entrapped a great quantity of fiery vapour by a special apparatus. As a matter of fact, he had wanted to carry out a suggestion made by Prof. Ramsey that he should draw a quantity of the air of the upper regions through guncotton to see if it left any special residuum of dust behind, but he had not yet tested his results, in fact, his belief was that there would be and could be no results. There was no possibility of their getting any traces of meteoric dust on that particular day. At dawn they realised that they were fairly caught in a trap. They were at a height at which it was impossible to open the valve. Their balloon had remained poised until

then, but it would not poise much longer. The sun began to assert itself. The large amount of condensation on the silk began to dry, and the gas within began to expand with the heat, with the result that the balloon rose rapidly—at the rate, in fact, of 600 ft. every quarter of an hour. This went on for two hours or more, until in the end they were nearly two miles high. For the early part of the time they could hear the sounds of earth, but these at last died away, and, while they heard nothing, they could only see the upper surface of the clouds, which, from its extreme whiteness, looked like the purest snow. The speaker then dealt with the nature of the upper currents, and, proceeding, said they came to the conclusion that there was nothing to be done but to let the balloon come down by itself. At about noon they heard the sounds of the pounding of great hammers, and they took it that they were over Bristol. Feeling convinced they were somewhere near possible help, they organised a system of aërial telegraphy, and, having written several copies of the following—"Large balloon "overhead, above clouds; cannot descend. Telegraph to sea-"coast (coastguards) to be ready to rescue, BACON, SPENCER"—they scattered them in mid-air. Only one of these had been traced, having been picked up on a Welsh mountain; the others doubtless fell into the Bristol Channel. Later they heard the splash of the waves on the shore—a continual sound as of explosion upon explosion; this was unmistakable. For some 20 miles, evidently, they were travelling over the sea. At last the balloon reached its culminating point, and when they next looked it had dropped 2,000 ft., owing possibly to some cold current setting up the estuary of the Severn. They saw it was the beginning of the end, but it was two hours more before their monster balloon would at last succumb. As soon as they got through the clouds, the sun being shielded, their descent became rapid; but their aëronaut would throw out no sand until they were near earth. They fell a great distance with extreme velocity. It was the first impact with the earth that fractured his daughter's arm, and the balloon then dragged itself with considerable force over the rough country. It got caught in an old oak of considerable dimensions, carrying away a huge limb.

Mr. Bacon's remarks were illustrated by many excellent lantern slides, one being a photograph of the "Victims" (as he described himself and his daughter), after they had left the balloon. He added that many Welsh friends kindly came to their rescue.

Mr. Bacon, in making a brief reference to next year's eclipse of the sun, and the arrangements proposed to be made on behalf of the Association in connexion therewith, said he had consulted one of the transatlantic lines, and they assured him that those who wanted to witness the eclipse in America would find it easy enough to get there, but getting home would be the difficult matter, owing to the Paris Exhibition. It was necessary, therefore, that passages should be booked, at any rate, within a week or two from the present time. The voyage should not be very costly—pretty much, in fact, as on the *Norse King*, which was about 30*s*. a day.

The meeting adjourned at 7 p.m.

Reports of the Branches.

NORTH-WESTERN BRANCH (MANCHESTER).

The Second Meeting of the current Session was held on November 1, when—it being also the annual business Meeting—the Treasurer and Secretary each presented his report for the past Session, and the President and Council for the current Session were elected.

The Secretary's report showed that the average attendance at the ordinary monthly meetings had been 25 members; and the membership of the Branch numbered 73 at the close of the Session as compared with 70 at the corresponding period last year. The Treasurer's report was also satisfactory.

The ballot for Officers having been taken, the result was declared by the Scrutineers (Messrs. Holland and Oldham) to be as follows:—

President	Prof. T. H. Core, M.A.
Vice-Presidents	Alfred Brothers, F.R.A.S. Samuel Okell, F.R.A.S. Rev. W. Sidgreaves, S.J., F.R.A.S. Thomas Thorp. E. T. Whitelow, F.R.A.S.
Treasurer	Henry Planck.
Secretary	Thomas Weir, F.R.A.S.
Other Members of Council	Samuel Broughton. Albert A. Buss. Samuel Chatwood, F.R.A.S. J. W. Hallam. H. Krauss Nield.

A paper on the Leonids was read by Mr. James Wilson, with special reference to the expected display about the 15th instant. The lecturer, after introducing his subject, referred to the study of meteors, and to our knowledge of their movements, as a development of 19th century astronomy. He referred to the displays recorded in history; to the contributions made on the subject by Dr. Olbers, of Berlin, Prof. Newton, of America, Prof. Adams, of Cambridge, and to others. By diagrams the lecturer showed the path of the meteors in relation to the orbit of the earth, dealing also with the disturbing effects of the outer planets, and, passing on, made more minute reference to the display expected at the middle of the month. The enthusiasm of the Members was thus stirred to take action in observing the Leonids, and Mr. Wilson concluded his paper by reading a communication the Secretary had received from Mr. W. F. Denning (Director of the Meteoric Section of the Association), in which special instructions were given as to the best methods of making the observations desired.

Mr. T. Thorp next exhibited a new experimental apparatus for showing grating photographs in their natural or any desired

colours without the use of dyes, pigments, or coloured screens, and demonstrated on the blackboard the principles underlying the invention.

At the outset, he apologised for bringing the subject before the Members, but as his grating replicas, by means of which he had been able to obtain the results shown in the apparatus, were first shown at one of the Meetings of this Branch (they are now made up in a variety of instruments from plane gratings to prominence spectroscopes), he thought that perhaps the subject, although not strictly astronomical in any sense, might still be interesting to the Members, and possibly some use might eventually be made of the method, even in astronomical research as in a solar eclipse.

These replica films, as is well known, contain lines or groves nearly 15,000 to the inch, and the first and most important problem to be solved was, how to reproduce them so that the quality of the surface covered by the lines would exactly correspond with the intensity and quality of the light falling upon any object the photograph of which it is desired to show, by means of some form of apparatus, in its natural colours.

Lines up to 5,000 to the inch can without any difficulty be reproduced on a chromated gelatine plate by contact only, a sufficiently powerful light being necessary, of course, and many beautiful specimens have been so produced by Lord Rayleigh, C. P. Butler, A.R.C.S., and others, and, latterly, by Prof. Wood, to whose ideas on the production of coloured pictures by diffraction Mr. Thorp was indebted as starting him in the train of thought which resulted in the present invention, whereby it is now possible to produce with the greatest ease and certainty photographic grating pictures in lines of almost any degree of fineness, and it has been found that to give satisfactory results lines of at least 15,000 to the inch are necessary.

After having described his method of making these grating photographs, he went on to say that, seeing only one ruling was available, it was necessary to arrange the lines composing the photographs at slightly varying angles when the pictures are superposed, in order that each should transmit its own particular colour, the disposition chosen in the apparatus exhibited being, for the green, horizontal, and for the red and blue-violet, 10° from the horizontal to the right and left respectively.

This arrangement entailed three, and in the stereoscopic apparatus shown, six sources of light to properly illuminate the slides.

By a simple arrangement of mirrors on the inner side of portions of an ellipse of revolution, however, *one* source of light is all that is necessary—a Welsbach burner being very suitable.

In addition to the usual eye-lenses necessary in the ordinary stereoscope, a pair of other lenses are placed just above the slides, for the purpose of forming spectra at a short distance from the eye-lenses, and at which point the eye must be placed in viewing the pictures, apertures in a plate being provided for the purpose.

The particular slide shown was a vase of flowers, which stood out in colours of great vividness and purity, and much astonishment was manifested when it was shown how the colours in the

picture could be varied at will by simply altering the angle of the incident beam.

Generally the apparatus was much appreciated, as being a distinct advance in the methods of showing photographs of objects in their natural or other desired colours, as well as in its application to the production of coloured designs.

Mr. Thorp informs us that since the meeting, Dr. Ames of Johns Hopkins University, where the celebrated Rowland gratings are produced, has kindly signified his willingness to assist in the production of a special grating, which will, it is confidently believed, not only very much simplify the method of reproducing the photographs, but also the apparatus necessary for their exhibition, as well as render them more suitable for projection in the lantern.

NEW SOUTH WALES BRANCH (SYDNEY).

The fifth annual Meeting of the Branch was largely attended by Members and visitors on the 17th October, 1899, when the President (Rev. Dr. Roseby) occupied the chair.

The result of the ballot for the Council for the session 1899–1900 was announced as follows:—

President - -	Rev. Thos. Roseby, M.A., LL.D., F.R.A.S.
Vice-Presidents -	W. F. Gale, F.R.A.S.; Hugh Wright.
Hon. Treasurer -	G. H. Halligan.
Hon. Secretary -	T. W. Craven, junr.
Hon. Librarian -	Miss C. Maclellan.
Other Members of Council.	T. H. Close. C. W. Darley, M.Inst.C.E. H. H. Edmonds. T. F. Furber, F.R.A.S. G. H. Knibbs, F.R.A.S. C. J. Merfield, F.R.A.S. J. Tebbutt, F.R.A.S.

The secretarial report was read, stating that during the year ten meetings had been held, at which the average attendance had been 16 members and 5·5 visitors; four papers had been contributed and 16 addresses delivered, and on four evenings there had been lantern exhibitions. In February the Government Astronomer entertained a large number of the Members at the observatory; and also during the session, another Member, Dr. Quaife had delivered at his residence a lecture on "Polarised Light," which was likewise largely attended by the Members. The session, which had been in all respects a successful one, closed with a membership roll of 53.

The treasurer's report and balance sheet, showing a credit balance of 6*l*. 7*s*. 10*d*., was read and adopted.

A copy of the Report on the Indian Eclipse, 1898, was presented to the Library by Mr. Halligan.

The presidential address on "A Plea for the Stars" was delivered by the Rev. Dr. Roseby. After dwelling on the beauties of the science, an eloquent appeal was made for the study of our southern sky, and special mention was made of the need of a catalogue of Southern Double Stars, which would be of immense service to workers, since there was no such catalogue at present available. New South Wales had done much through the labours of Russell, Sellors, and Innes, but alongside the results of the Lowell Observatory, it was evident that there was still an immense scope for a systematic survey of the southern sky, and such a survey may result in the furtherance of other branches of observational astronomy, such as the discovery of variable stars, comets, and radiant points of meteoric showers. Special mention was made of the fine mathematical computations of Mr. C. J. Merfield, and the able address was concluded by a review of recent astronomical progress.

On the motion of Messrs. Knibbs and Macdonnell, supported by Mr. Gale, a vote of thanks was enthusiastically accorded to the President for his address.

Mr. W. F. Gale, in a short address, reviewed his observations of the Zodiacal Light, which, on the whole, agreed with those made by Mr. Bayldon, in other latitudes.

Mr. John Tebbutt reported having observed the position of the periodical comet Tempel 1873 II. on 43 nights between 1899, July 2 and October 7.

The meeting concluded with an exhibition of lantern slides, the demonstration being given by Messrs. Gale and Wright.

EAST OF SCOTLAND BRANCH (EDINBURGH).

The second Meeting of this Branch for the current Session was held at No. 5, St. Andrew Square, Edinburgh, on Friday, 17th November, the President in the chair.

The lecturer for the evening was the Rev. P. Hately Waddell, B.D., F.R.A.S., his subject being the Moon. With the aid of a large number of limelight views, the motions of the moon were admirably dealt with, its positions at different parts of the year, its librations and eclipses, being lucidly explained in a most interesting way.

Mr. Waddell then showed a number of his photographs of the moon, making a few remarks on the difficulties attendant upon lunar photography, and afterwards showed photographs of some of his drawings of portions of the lunar surface. These photographs and drawings were beautifully executed, and were much appreciated by the Members. After a few remarks, Mr. Waddell was cordially thanked for his most interesting address.

Some discussion then took place upon the Leonid Meteor shower, but none of those present had observed anything beyond the normal display.

WEST OF SCOTLAND BRANCH (GLASGOW).

The second meeting of the Sixth Session was held in the Athenæum on Friday evening, 17th November, Mr. John Dansken, F.R.A.S., Vice-President, in the Chair. It was intimated that the parent association had agreed that students attending astronomical classes should be admitted as associate members, on payment of a nominal fee; and that Prof. Jack, M.A., LL.D., had accepted the position of honorary president of the Branch. Six new members were nominated. The Chairman then read notes on the constellations in the southern meridian during November, including Cetus, Pisces, Aries, and Andromeda; referring specially to the wonderful variable Omicron Ceti, and the remarkable nebula in Andromeda (31 Messier), illustrated by lantern views. The secretary, Mr. John Main, F.G.S., exhibited a series of mechanical lantern views illustrative of the evening's lecture. The president, Rev. Edward Bruce Kirk, then delivered a lecture on the Solar System. He treated, first, of the unity of the system, as ruled by the sun; second, of the stability of the system as secured by its isolation and compensation for disturbance; and, lastly, of the variety of the system shown in the varied ages and conditions of the planets. The lecturer treated these characteristic features of our own system in a very comprehensive manner, so far as time permitted. Mr. Kirk spoke of the overwhelming mass of the sun as compared with the total mass of the planets, satellites, &c. ruled by him; followed by black board illustrations of the real and apparent motions of the planets in their orbits, explaining very concisely and clearly the cause of the apparent loops described by them during direct and retrograde motion, through being viewed from a swiftly moving globe like our earth. The lecturer pointed out these orbital motions as being entirely due to gravity; also giving some blackboard illustrations elucidating Kepler's laws, and demonstrating very simply and clearly how the radius vector sweeps over equal areas in equal times, in accordance with Kepler's second law, as enunciated by that eminent astronomer. Mr. Kirk referred briefly to the harmony of the solar system, as, although constantly subject to perturbations, exercised mutually between each body; these were disturbing elements affecting the stability of the system within certain limits, duly compensated for; and, except some, at present, unknown and extraneous influence should come within range of our system and cause disarrangement, we had every reason, from the experience of the past, to believe in the endurance of the system as existing now. The reverend gentleman also gave a very interesting and instructive series of pendulum experiments, illustrating how bodies with commensurable periods communicated or imparted motion, and otherwise affected each other, in contradistinction to the mutual influence exerted on each other by bodies with incommensurable periods. These experiments proved very interesting and instructive as illustrating the lecturer's remarks. Some enjoyable discussion followed, and after being replied to by Mr. Kirk the meeting closed with a hearty vote of thanks to the lecturer and the chairman.

Reports of the Directors of the Observing Sections.

Meteoric Section.

(*Interim Report II.*)

THE NOVEMBER LEONIDS OF 1899.

The Director of the Section has received a large number of reports of this shower from observers in various parts of the country. These reports are from both Members and non-Members of the Section, and testify to the widespread interest awakened in the event, and to the earnest efforts made to witness it.

But there was a general failure. The meteors did not appear in the numbers expected; in fact the display was not more rich than an ordinary shower of the August Perseids. The comparatively negative results were due to several circumstances. Primarily, no doubt, the cause was that the earth traversed a tenuous region of the swarm in front of the denser part which gave rise to the brilliant displays in 1833 and 1866. At many places the weather was very unfavourable; there was bright moonlight everywhere, except for a brief interval, and quite possibly the shower was at its best during daytime in England. But from telegraphic reports in the newspapers, it would appear that the phenomenon similarly disappointed observers in other countries. No intelligence has yet come to hand of a really brilliant display in any part of the world.

The occasional appearance of Leonids on the mornings of November 14, 15, and 16, proved that the earth encountered the stream at the usual time, but the strength of the display seemed little greater than it was in the years 1879 and 1888, when the parent comet (Tempel 1866 I.) was not very far from Aphelion.

The observations of the recent shower are somewhat at variance in regard to several of the more important features, but they lead to the following conclusions:—

1. The duration of the shower was from November 8 to 18 inclusive.
2. The maximum occurred on November 14 in the hour between 17^h and 18^h, when, however, not more than 25 Leonids was visible to one observer.
3. The radiant point was at $151\frac{1}{2}^\circ + 22^\circ$.
4. The radiant was probably a fixed position according to the paths of several early Leonids, but the evidence they afforded is, perhaps, not conclusive.

Mr. King, at Leicester, says the area of radiation extended over four degrees.

The following is a summary of some of the principal observations :—

Summary of Observations of Meteors at the Leonid Epoch, 1899.

Date.	Hours of Observation.	Duration of Watch.	Meteors seen.	Leonids.	Notes.	Observer.
	h	h m				
Nov. 8	After 13¾	2 0	17	—	Clear -	A. S. Herschel, Slough.
	h m h m					
„ 8	10 55 to 13 10	2 15	22	2	Clear -	W. E. Besley, London.
„ 8	14 0 „ 15 0	1 0	7	—	Clear -	R. Service, Dumfries.
„ 8	16 0 „ 17 45	1 45	13	—	Clear -	A. King, Leicester.
„ 10	11 0 „ 13 0	2 0	27	1	Clear -	T. H. Astbury, Wallingford.
„ 10	11 25 „ 14 0	2 35	13	0	Clear -	W. E. Besley, London.
„ 10	12 40 „ 14 40	1 30	13	0	Partly cloudy	W. F. Denning, Bristol.
„ 10	13 0 „ 15 30	2 30	19	0	Clear -	A. S. Herschel, Slough.
„ 10	16 40 „ 18 10	1 30	11	—	Clear -	R. Service, Dumfries.
„ 10	16 30 „ 18 0	10	3	—	Very cloudy	A. King, Leicester.
„ 11	14 30 „ 16 30	1 30	10	2	Many clouds	W. F. Denning, Bristol.
„ 12	17 30 „ 18 0	30	2	1	Mist and cloud.	A. S. Herschel, Slough.
„ 13	14 0 „ 14 30	30	35	—	Seen through a rift.	Lucy Johnson, London.
„ 13	17 0 „ 18 10	15	2	—	Very cloudy	A. King, Leicester.
„ 13	17 0 „ 18 25	1 25	23	—	Clear -	A. R. Hinks, Cambridge.
„ 13	17 8 „ 17 50	42	9	7	Cirrus haze	J. E. Clark, Croydon.
„ 13	17 15 „ 18 0	45	5	1	Sky ½ clear -	W. F. Denning, Bristol.
„ 13	17 20 „ 18 30	1 10	21	18	Clear -	H. Savary, Marlborough.
„ 14	10 0 „ 18 0	—	98	66	Clear -	Sir W. J. Herschel, near Oxford.
„ 14	11 0 „ 16 0	3 35	7	6	Cloudy and misty.	J. Evershed, Kenley.
„ 14	12 0 „ 17 10	5 10	24	—	—	W. C. Tetley, Aspley Guise, Beds.
„ 14	12 5 „ 16 35	4 30	45	—	Fog, 4 observers.	A. R. Hinks, Cambridge.
„ 14	12 7 „ 14 57	2 50	15	12	Clear -	Col. E. E. Markwick, Devonport.
14	13 30 „ 14 15	45	1	1	Pretty clear	A. S. Herschel, Slough.
„ 14	14 30 „ 18 0	3 30	28	24	Slight haze	R. J. Ryle, Brighton.
„ 14	15 0 „ 18 0	3 0	200	—	Several observers.	A. R. Schutz, Worthing.
„ 14	15 15 „ 18 15	3 0	50	44	Clear, 4 observers.	Oxford undergraduates.
„ 14	16 3 „ 17 53	1 50	—	37	Much fog -	T. H. Astbury, Wallingford.
„ 14	16 30 „ 18 0	1 30	65	—	—	Observed at Brighton.
„ 14	16 30 „ 18 0	1 30	—	45	Clear, several observers.	W. H. Daw, London.
„ 14	16 30 „ 18 15	1 45	89	70	2 observers -	Col. R. Williams, Dorchester.
„ 14	16 45 „ 18 4	1 19	18	14	Clear -	Col. G. L. Tupman, Harrow.
„ 15	10 0 „ 18 26	2 3	10	4	Fog - -	T. W. Backhouse, Sunderland.

Date.	Hours of Observation.	Duration of Watch.	Meteors seen.	Leonids.	Notes.	Observer.
	h m h m	h m				
Nov. 15	12 0 to 16 30	4 30	14	8	—	A. C. Allen, Eccleshall.
	16 30 „ 18 45	2 15	30	19		
„ 15	12 25 „ 18 30	6 5	72	—	Partly cloudy, 4 observers.	A. R. Hinks, Cambridge.
„ 15	13 15 „ 17 15	4 0	16	10	Fairly clear	A. King, Leicester.
„ 15	13 30 „ 18 30	5 0	20	15	Partly cloudy	R. Service, Dumfries.
„ 15	12 48 „ 14 47 / 16 43 „ 18 28	3 45	17	12	Clear -	Col. E. E. Markwick, Devonport.
„ 15	14 0 „ 15 12	1 12	12	10	—	J. A. Greenwood, Chichester.
„ 15	15 30 „ 18 0	2 30	—	23	Clear, several observers.	R. Killip, St. Anne's-on-Sea.
„ 15	16 0 „ 17 0	1 0	9	--	Clear -	C. Whyte, Shetland.
„ 15	16 30 „ 16 50	20	3	3	Partly cloudy	J. Evershed, Kenley.
„ 15	Whole night	--	19	--	Slight haze	J. Baxendell, Southport.

The appended is a list of some of the bright meteors recorded, and the Director would be glad to hear of duplicate observations of these objects:—

Date, 1899.	G.M.T.	Mag.	Observed Path. From		To		Appearance.	Radiant.	Observer.
	h m		α °	δ °	α °	δ °		° °	
Nov. 8 -	11 26½	1	72	+ 45	135	+ 60	S. T. -	Taurid -	W. E. B.
„ 8 -	11 33	1	72½	+ 12½	89	+ 3	S. -	Taurid -	W. E. B.
„ 8 -	12 23½	1½	130	+ 27	111	+ 28	R. K. -	L. -	W. E. B.
„ 8 -	12 46	1½	70	+ 27½	100	+ 32	M. - -	Taurid -	W. E. B.
„ 8 -	16 27	1	153½	+ 24	151	+ 28½	R. K. -	L. -	A. K.
„ 8 -	17 15	1	137½	− 2½	141½	− 8	R. K. -	130 + 20	A. K.
„ 8 -	17 39½	1	166½	+ 3	175½	− 2	Starlike -	130 + 20	A. K.
„ 10 -	12 7	1	42½	+ 49	51	+ 74	S. - -	Taurid -	W. E. B.
„ 10 -	13 8	> 1	31	− 9	25½	− 14	S. - -	Taurid -	A. S. H.
„ 10 -	13 8½	> 1	337	+ 40½	330	+ 35	R. K. -	121 − 1	A. S. H.
„ 10 -	17 8	1	141	+ 22	145½	+ 20½	R. K. -	Gemini	A. K.
„ 12 -	17 59	> 1	100	+ 18	85	+ 14	R. - -	L. -	A. S. H.
„ 13 -	12 43	♃	110	+ 7	83	− 2	—	L. -	J. H. P.
„ 13 -	13 57	1	116	+ 25	95	+ 23	—	L. -	J. H. P.
„ 13 -	15 52	1	72	+ 33	50	+ 25	R. - -	143 + 29	A. S. H.
„ 13 -	16 52½	1	123	+ 11	119	+ 3	v R. -	142 + 50	A. S. H.
„ 13 -	17 28	1	176	+ 31	168	+ 22	K. - -	262 + 61	J. E. C.
„ 13 -	17 39	1	143	− 6	140	− 11	R. K. -	168 + 30	J. E. C.

Date, 1899.	G.M.T.	Mag.	Observed Path. From		Observed Path. To		Appearance.	Radiant.	Observer.
	h m		α °	δ °	α °	δ °		° °	
Nov. 14	13 31½	1	113	+ 27	95	+ 29	R. K.	L.	A. S. H.
„ 14	16 35	1	161	+ 30	171	+ 35	R. K.	L.	T. H. A.
„ 14	16 47	1	89	+ 11	79	+ 7	R. K.	L.	T. H. A.
„ 14	16 48	> 1	112	− 11	104	− 16	R. K.	L.	T. H. A.
„ 14	16 57	1	190	+ 29	202	+ 30	R. K.	L.	T. H. A.
„ 14	16 59	1	139	+ 42	133	+ 47	R. K.	L.	T. H. A.
„ 14	17 0	> 1	183	+ 13	195	+ 9	R. K.	L.	T. H. A.
„ 14	17 8	> 1	142	− 11	162	− 16	S.	Taurid	T. H. A.
„ 14	17 9	1	147½	− 6	147	− 16	R. K.	L.	T. H. A.
„ 14	17 20	♃	160	+ 73	270	+ 85	R. K.	L.	T. H. A.
„ 14	17 25	> 1	146	+ 24½	145	+ 25½	K.	L.	G. L. T.
„ 14	17 28½	1	192	+ 51	207	+ 55	R. K.	L.	T. H. A.
„ 14	17 38	> 1	105	− 12	91	− 22	R. K.	L.	T. H. A.
„ 14	17 40	♃	163	+ 63	70	+ 66	R. K., 5 min.	193 + 27	Sir W. J. H.
„ 14	18 8	> 1	170	+ 18	200	+ 15	v R.	L.	R. S.
„ 15	13 20	1	153	+ 40	155	+ 47	v R.	L.	A. K.
„ 15	13 53	1	201½	+ 50½	211½	+ 52	v R.	L.	A. K.
„ 15	14 6	1	162½	+ 35½	164	+ 37	v R.	L.	A. K.
„ 15	14 39	> 1	157	+ 29	153	+ 25	R. K.	Ursa Maj.	A. K.
„ 15	14 52	> 1	149½	+ 40	147½	+ 46½	R. K.	L.	A. K.
„ 15	15 13½	1	179	+ 50	207	+ 55	v R.	L.	R. S.
„ 15	15 27	1	182	+ 19	203	+ 10	v R.	L.	R. S.
„ 15	16 43	> 1	127	+ 12	113½	+ 5½	K.	L.	R. K.
„ 15	16 47	♀	Path 20°		To N.N.W.		K., 2 min.	L.	R. K.
„ 15	16 50	> 1	130	+ 5	120	− 3	v B. flash	L.	R. S.
„ 15	16 51	♀	136	+ 11	127	+ 4	K., 3 min.	L.	A. C. A.
„ 15	18 25	1	135	+ 27	192	+ 31	v R. K.	Eridanus	R. S.

One of the finest meteors observed was that seen by Sir W. J. Herschel at Littlemore, near Oxford, on November 14th, $17^{h}\ 40^{m}$. It left a streak for five minutes. It was also recorded by several undergraduates at Jesus College, Oxford, who describe it as large and very brilliant, and leaving a train for three minutes. The Rev. T. E. R. Phillips, at Yeovil, saw it as it crossed a rift in the clouds, and Mr. W. C. Tetley, at Aspley Guise, Beds, says it was the most brilliant meteor he observed. From a comparison of the various observations it seems the meteor was directed from a radiant at $193° + 27°$, and that it fell from a height of 71 miles over a point four miles S. of Buckingham to 42 miles over a place three miles S. of Shipston, Warwick. Earth point five miles N. of Hereford. Its length of path was 46 miles.

Some remarkable reports on the shower have appeared in the newspapers, and I am much indebted to Mr. W. H. S. Monck for sending a large number of cuttings. I quote a few of the most noteworthy :—

Wicklow.—Some workmen in this neighbourhood proceeding to their employment on Monday morning, November 13th, about 6 o'clock, were much surprised and frightened to see, what they described as lights like candles falling from the sky.—*J. Usher.*

Brighton.—Between 4.30 and 6 a m. on Wednesday, November 15th, I and a friend were rewarded by seeing a magnificent display of shooting stars. Their direction was towards the Great Bear, and they left trails of light behind them. We counted between 60 and 70.—*N. M.*

Birmingham.—We waited long and patiently, and at 1.15 a.m. on Thursday, November 16th, the clouds began to disperse, and there were revealed to our eyes some of the long looked for meteors. They were easily discernible, and varied in colour from a bright white to a light red. They were travelling in a N.E. direction. Many of them were exceedingly large and brilliant. The time would be about 1.30 to 1.45. If we had had a telescope in our possession it would indeed have been a grand sight.—*L. H.*

North Streatham.—About 2 a.m. Thursday morning, November 16th, the clouds slightly broke, and during the next half-hour I and two others saw 30 or 40 Leonids. As this number was seen in such a small rift of the clouds we may conclude that a considerable shower was going on.—*Lucy Johnson.*

Liverpool.—I saw the meteoric showers on Thursday afternoon, November 16th. I first noticed them at 0.15 p.m., they were shooting in all directions, and kept on until about 4 o'clock. On Friday afternoon I saw them again, and called the attention of several people who could also see them. Owing to the bright sky one had to stare for a few seconds before perceiving the stars as they were very dazzling to the eyes.—*M. Arden.*

Denver.—The Leonids began to be seen at 1 a.m. November 16th, but did not follow each other in rapid succession until about 4 a m., when 63 were counted in a quarter of an hour.

Burnley.—While the Mayor of Burnley and a friend were out walking on Saturday November 18th, at Clitheroe, they noticed a large quantity of gray-looking material which had pattered through the trees and made a noise like rain. On the way to Burnley they passed other pedestrians who had noticed the same phenomenon. "There is little doubt that the debris was meteoric dust which in some places had fallen in large quantities."

From *Southport* Mr. Baxendell has reported to the Director that on Thursday morning, November 16th, two observers there were much struck with a peculiar beam or arc of light which appeared faintly at 0.45 a.m., had become very definite by 1.30 a.m., and faded away soon after 2 a.m. It appeared to rise from the haze in the N.E., to very slowly move towards the S.W. (passing through N.W.), and sink into the haze. The direction of the beam was from S.W. to N.E. It was decidedly broader at

one end (the N.E.) than at the other, being shaped like a wedge. It certainly was no cloud. It was slightly but distinctly curved, and just resembled the tail of a large comet. Mr. Baxendell says that he supposes it must have had an auroral origin, but it was a strange exhibition, and must have been bright, as the moonlight was very strong. It was not of great length.

It would be interesting to hear whether any such appearances were observed elsewhere.

W. F. Denning,
Director of the Section.

Papers communicated to the Association.

Le Courant équatorial de Jupiter.

By J. Comas Solà.

Parmi les très intéressants problèmes qui nous offre l'étude physique de Jupiter, un des plus notables est sans doute celui du courant équatorial.

Si nous examinons les résultats obtenus depuis quelques années par bon nombre d'astronomes, nous ne pouvons moins d'être tout à fait surpris du brusque changement de vitesse des taches équatoriales par rapport à toutes les taches restantes de la surface de Jupiter. Nous remarquons, d'abord, que la durée générale de rotation des taches de cette planète est au peu près celle du II. système des éphémerides. D'ailleurs, les taches plus stables en forme et mouvement, entre autres le *tache rouge* et les bandes équatoriales, taches qui sont celles qui se trouvent sûrement dans la plus intime rélation avec la planète, appartiennent au système II., et même pour ces dernières les rotations sont les plus longues. D'autre côté, toutes les observations confirment que les taches du courant équatorial, blanches et noires, se trouvent à un niveau supérieur aux bandes équatoriales et aux taches du système II. Il faut, donc, admettre de toute nécessité, je crois, une force *spéciale* et *constante* pour provoquer le mouvement relatif des taches équatoriales (de plus de 400 km. à l'heure), mouvement uniforme, ou au peu près, dans tout le contour de l'équateur jovien et sûrement séculaire, du moins il existait déjà du temps de Cassini.

Quelle peut être cette force? C'est que j'intente chercher dans ce travail. Supposons, en premier lieu, que l'origine d'énergie se trouve dans la planète même. Je doute que personne peuve concevoir que les bouleversements produits dans une planète encore chaude, bouleversements qui ne sont régis par aucune loi, soient aptes pour donner lieu à un mouvement continu, uniforme, seulement dans une zone et suivant exactement des parallèles jovigraphiques. Je comprends bien que ces mouvements internes pourront originer la formation et dissolution de taches et être la cause de grands troubles et de changements irreguliers de tout genre, des effets tourbillonnaires, des phénomènes où se manifestent l'action et la réaction, mais jamais d'un mouvement que toujours s'accomplit dans le même sens, avec la même vitesse et suivant le même chemin.

Cherchons une force externe. La première que nous nous rappelons c'est le Soleil, mais alors l'explication devient encore plus difficile. D'une part, la quantité de chaleur reçu par Jupiter dans l'unité de surface est beaucoup plus faible que sur la Terre, et nous savons bien qu'ici jamais il donne lieu à des mouvements atmosphériques aussi épouvantables, du moins jusqu'à l'hauteur des cirrus les plus élevés. D'autre côté, on ne s'explique pas comment le mouvement originé par le Soleil peut suivre exactement des parallèles, ayant compte que ce genre de mouvement tient par fondement la différence thermique entre les hautes latitudes et les régions équatoriales. Il me semble, enfin, comme absolument insoutenable que ce courant soit une sorte d'alizées.

A mon avis, la cause est certainement extérieur à la planète, mais cette cause est un satellite, ou meilleur, peut-être, plusieurs satellites, invisibles, très petits et très proches de la planète, se mouvant autour de Jupiter avec une vitesse angulaire un peu plus rapide que celle de la planète.

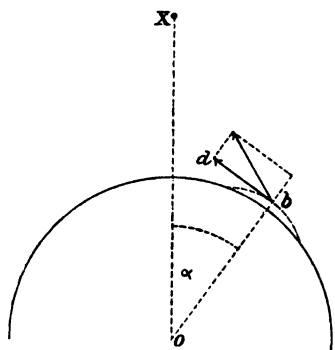
Examinons de plus près la question. On sait que M. Barnard a decouvert recemment un nouveau satellite d'un ordre de grandeur bien inférieur aux autres. Il se trouve du centre de la planète à la distance 2.65, en prenant le rayon de Jupiter par unité. Si sa densité est au moins égale à celle de la planète, il se trouve, selon la loi de Roche, à une distance suffisante pour avoir pu se former sans se subdiviser en fragments. Mais eu égard aux grandes analogies que Jupiter présente avec Saturne, on peut admettre comme possible et probable l'existence de quelque autre masse entière ou subdivisée correspondant à une distance inférieure à la limite de Roche (= 2.44 pour densités égales), par exemple, 2.0 ou moins. Si la densité d'un satellite fluide primitif était inférieure ou peu supérieure à celle de Jupiter, elle a dû se subdiviser en plusieurs corps, formant les rudiments d'un *anneau*, qui peut être invisible par la faible quantité de corpuscules qui le composent, c'est-à-dire un anneau incomparablement plus transparent que l'anneau intérieur de Saturne. Sans varier les conclusions, on pourrait accepter aussi un satellite unique et d'une densité très supérieure à celle de Jupiter roulant, par exemple, à la distance 2.0, mais, dans tous les cas, en supposant que le plan de son orbite coïncide au peu près avec celui de l'équateur jovien.

Examinons le cas d'un seul satellite, l'autre cas ne serait qu'une extension du premier. Malheureusement, les données font défaut pour faire des calculs précis, même en attributant des valeurs arbitraires. Mais nous pouvons dans certains limites concevoir la possibilité de quelques résultats.

Si nous supposons la distance égale à 2.0, le temps de révolution de notre satellite autour de Jupiter, selon la 3^{e} loi de Kepler, sera égal à 8^{h} au peu près, c'est-à-dire que la vitesse du mouvement angulaire de translation du satellite sera un peu plus rapide que la rotation de la planète. Acceptons de plus que son diamètre soie de 400 km. et sa densité égale à la moitié de celle de la Terre; sa masse par rapport à notre globe sera 70,000 fois, en nombres ronds, plus petite.

Sans doute que, malgré la petitesse de la masse de ce satellite, que j'appelerai X, il peut produire, à cause de la faible distance de la planète, une marée bien sensible dans les couches hautes de

l'atmosphère de Jupiter, mais cette marée présenterait bien des différences avec les marées luni-solaires de la Terre. D'abord, elle s'exercerait suivant des lignes de force très convergentes, et, d'autre partie, l'attraction de X diminuerait très rapidement augmentant les distances, de telle sorte qu'au lieu de se produire des ondes diamétralement opposées et une déformation ellipsoidale dans la surface du niveau de l'atmosphère de Jupiter, il résulterait seulement une prominence assez pointue dans la zone équatoriale de Jupiter et dans la face qui regarde X. Dans l'autre côté diamétral de la planète, cette protubérance serait insensible. La propagation de l'onde atmosphérique ou protubérance équatoriale aurait le même période que la révolution de X, pourtant son mouvement relatif sur la planète serait assez lent et dans le sens de la rotation. On sait que sur la Terre la marée lunaire terrestre forme avec la Lune un angle horaire considérable, ce qui fait que l'haute mer arrive quelques heures après le passage de la Lune par le méridien. Ce retard est dû aux frottements très considérables qui souffre l'onde maritime en se propageant. Dans l'atmosphère de Jupiter, les résistances doivent être beaucoup moindres que dans les mers terrestres, mais ces résistances existiront toujours dans l'atmosphère jovienne, même dans ses couches plus hautes.



Admettons que l'angle horaire entre le satellite X et le flux atmosphérique jovien soit de 5° seulement. Examinons dans ces conditions l'effet mécanique du satellite sur le flux. Soient X le satellite, O le centre de Jupiter, A le sommet du flux; pour plus de clarté, je dessine l'angle horaire α supérieur à 5°. A part l'action de X pour la production d'ondes dans l'atmosphère de Jupiter, nous voyons s'exercer clairement une autre action qui est insensible dans les marées lunaires, mais qu'ici, par des circonstances spéciales, peut être très considérable : c'est l'attraction de X sur la protubérance A, qui pourra produire un mouvement de glissement ou entraînement des molécules fluides qui la forment dans le sens de la rotation de Jupiter, surtout pour les molécules plus hautes, qui se trouvent vers le sommet de la protubérance ou qui forment la région moins dense de l'atmosphère.

Avec les données établies, il est bien facile le calcul de la composante tangentielle *a b;* l'accélération résultante est égale à $0{\cdot}0002^{\mathrm{mm}}$ par seconde. Comme on voit, elle est une accélération bien faible. Faisant cas omis des résistances, ils faudraient

18 années pour produire la vitesse de 400 km. à l'heure. Mais il faut avoir compte encore que pour chaque molécule atmosphérique l'accélération a lieu seulement pendant une petite fraction de la révolution synodique du satellite X autour de la planète, en d'autres mots, que l'accélération s'accomplisse seulement à intervalles, ce qui allonge extrêmement à première vue le temps nécessaire pour produire à une molécule la vitesse de 400 km. à l'heure; mais on ne doit pas oublier que cette succession d'accélérations, imprimant le mouvement à *toutes* les molécules du contour de Jupiter, fait diminuer les résistances qu'éprouverait au mouvement une molécule obligée à se mouvoir dans un milieu en repos. D'ailleurs, le temps ne serait pour nous aucun obstacle, mais il faut aussi ne pas oublier qu'il peut y avoir des frottements moléculaires plus que suffisants pour qui à un certain moment détruissent cette faible accélération en reduisant la vitesse à des limites bien restreints ou presque l'annuler tout à fait. On peut répondre, cependant, que la matière jovienne dans les hautes couches de l'atmosphère, surtout si nous admettons qu'elle se trouve à une température élevée, peut être si rare, les espaces intermoléculaires peuvent être si grands par rapport au grandeur des molécules que les chocs entre elles représentent une perte de force vive insignifiante. On pourrait ajouter encore comme objection que les taches blanches et noires équatoriales semblent indiquer plutôt une certaine accumulation moléculaire qu'un état très disgrégué de la matière. Je prends cet objection comme sérieuse, mais loin d'être mortelle pour mon hypothèse, et je crois la vaincre en supposant, comme je disais tout à l'heure, non un seul satellite, mais plusieurs.

Dès ce nouveau point de vue, nous pouvons supposer l'existence d'un certain nombre de petits satellites représentant en totale une masse quelque considérable et qui tournent autour de la planète à des distances de 1.3 à 2.0, par exemple. Nous nous trouvons alors complètement dans la zone de désagrégation assignée par la théorie de Roche, du même que pour les anneaux de Saturne. L'accélération peut être dans ce cas beaucoup plus considérable (mais pas proportionnelle au nombre de satéllites) que dans le cas d'un seul satellite situé à la distance 2.0, et on pourrait expliquer d'une manière très satisfaisante le courant équatorial et même grand nombre de phénomènes que nous présente Jupiter. Quant au travail dépensé par le courant équatorial, il peut être relativement très faible. Cependant, il y a force vive dépensée dans le frottement de l'onde et dans le frottement des molécules dans son mouvement d'entraînement. Ces résistances ont tendance à augmenter la vitesse de rotation de la planète, et toute la force vive dépensée sera empruntée aux satellites. Il n'est pas difficile de faire un calcul prudent pour trouver l'accélération approchée qu'une protubérance atmosphérique détermine sur un satellite *moteur*, accélération qui produira une augmentation de vitesse du satellite, mais en faisant diminuer, par contre, la distance du satellite au planète. Il décrira en rigueur des spirales jusqu'à tomber sur la planète, mais le pas des spires est si petit, la diminution de distance si lente, qu'on peut compter sûrement par millions d'années le temps nécessaire pour qu'en des telles conditions un satellite tombe sur la planète, eu égard la faible masse atmosphérique de l'onde.

L'action de ces satellites serait surtout équatoriale, puisque l'attraction dans ce cas décroit très rapidement augmentant la distance. Cet action, d'autre côté, serait peu sensible dans les matières profondes, situées dans un milieu plus dense; telles seraient les grandes bandes équatoriales, la tache rouge, etc. D'autres détails élevés, mais se trouvant à des hautes latitudes jovigraphiques, pourraient avoir aussi un considérable mouvement d'entraînement, mais beaucoup moins rapide que dans la zone équatoriale, par effet de la plus grande distance aux centres d'attraction.

Les variations de vitesse de toutes les taches de Jupiter avec le temps peut s'expliquer par des changements physiques (densité, profondeur, etc.) qui doivent s'accomplir dans une planète qui se trouve encore dans son age primordiale ou par d'autres circonstances très complexes qui seraient très longues de renseigner ici.

The Shadows of Jupiter's Satellites.

By C. T. Whitmell, M.A., F.R.A.S.

In Vol. VIII. of "Journal," pp. 32–8, will be found a theoretical account of the changes in the shape of the shadows of Jupiter's satellites during transit, the planet being supposed in quadrature, so that the changes are at a maximum. Only the umbra is considered. On pp. 281–2 of the same volume are given some observations illustrating and confirming the theory. I now give some additional observations, which I hope may be of interest, and may lead to fresh evidence in the future.

Mr. Newall, of Cambridge, wrote to me as follows, on 10th August 1898: "I remember noting some years ago a " marked instance of the appearances you refer to. 16th March " 1895.—Shadow III. At ingress the shadow seemed to hang " on the limb for a long time, and was very egg-shaped." Mr. Newall's drawing shows that the shadow was elongated equatorially, with the sharp point of the egg towards the E. limb of the planet. At egress the shadow equatorially was quite narrow. Transit took about $3^h\ 14^m$, and occurred S. of the equator.

Opposition occurred on 22nd December 1894, and quadrature on 17th March 1895, so that the conditions were exceptionally favourable.

Mr. MacEwen (*See* "Journal," Vol. VI., p. 340), on 23rd February 1896, saw Shadow III. near ingress distinctly oval, the long axis being parallel to the equator. On the central meridian the shadow was circular. Egress was lost in cloud. Opposition occurred on 24th January, quadrature on 19th April.

Mr. Townshend, of Leeds, on 6th June 1899, saw Shadow I. elongated equatorially at ingress, and, on 15th June, saw it narrowed equatorially at egress. Opposition was on 25th April, quadrature on 24th July.

Mr. Stanley Williams, on 23rd February 1899 (about a month after the preceding quadrature of 28th January), saw Shadow III., near ingress, shaped as a narrow oval, the short diameter of which

made a small angle with the equator of the planet. As transit proceeded the shadow broadened and became almost circular near the central meridian. Egress was not seen.

Mr. Williams adds that, in 1898, though observing on every fine evening, he had not one opportunity for watching change of shadow-shape. He writes: "It became positively amusing to note how "the shadow-transits seemed specially to avoid those nights which "were fine here." (Brighton.)

Mr. Gledhill, of Bermerside, a very competent observer, informs me that he has often seen the shadows elongated, with axes in the ratios, 3 to 1, 2 to 1, and so on.

The foregoing observations are entirely in accord with the theoretical predictions given in Vol. VIII., pp. 32–8, where also will be found another very interesting observation by Mr. Stanley Williams, one of the leading authorities. I am still without any detailed record of the changes of shape of a shadow for a complete transit, when Jupiter is at or very near quadrature. For a quadrature, following opposition, the shadow equatorially is broad at ingress, but narrow at egress For a quadrature, preceding opposition, the reverse holds good. Whilst the height of the shadow, during transit, may remain practically unaltered, its width at the phase-limb may be six times greater than at the other limb. To see to perfection these changes in the shadow of a satellite we ought to be on another satellite, placed so as to view the shadow of the former one as squarely as possible. A satellite, near maximum elongation, would afford an excellent view of the shape of the shadow of the former satellite, when this shadow was at ingress or egress.

Tides on Jupiter.

By C. T. WHITMELL, M.A., F.R.A.S.

To what causes are due the remarkable surface-changes continually occurring upon Jupiter? The planet's high temperature is probably the main cause, but the tidal action of the satellites has also been suggested, and was specially brought before me by my friend, Mr. H. J. Townshend, an able and assiduous planetary observer. In the November "Bulletin" of the French Astronomical Society, M. Souleyre boldly affirms that the belts of Jupiter are due to his satellites, and vary in position and velocity with the configuration and velocity of the latter. This is truly an enormous assumption, and is unsupported by any calculations.

The general problem of the tidal effects due to the satellites is one of excessive difficulty, and quite beyond our present powers. But, assuming the equilibrium theory, it is easy to compare the tide-generating action of the satellites with that of our moon. Suppose the four satellites to lie in a straight line through the planet's centre. In this case the total tide-generating force upon Jupiter comes out about 25 times greater than that of our moon upon the earth. At first this seemed promising. But what we really want is the range of equilibrium tide at the equator; and, for the method of finding this, I am indebted to Prof. G. H. Darwin, of Cambridge, our highest authority upon tides.

By the aid of a formula supplied by him, I compute this range to be only some 48 feet. This is the sum of 28·3, 9·6, 9·0, 0·8, which are respectively the ranges in feet due to Satellites I., II., III., IV. If we take a shift of $0''\cdot 1$ as the smallest change appreciable by the telescope, a change corresponding to about 200 miles on Jupiter at a favourable opposition, we see that it is hopeless to recognise an alteration of only 48 feet.

Prof. Darwin writes:—"That this result is true only for an "equilibrium tide, and that dynamical action will make a great "difference. I do not think that any one could give a quanti- "tative conjecture as to the amount of kinetic augmentation of "the tides in Jupiter's atmosphere. The rotation of the planet "is rapid, and the periodic times of the satellites are short, so "that I should expect the augmentation to be considerable, but "certainly not so great as to give any visible effects."

It would be an interesting investigation to institute a comparison between the configurations of the satellites and the surface-changes of Jupiter, but I do not expect that any real connexion between the two would be discoverable.

The Shadow of Saturn's Ring on the Planet.

By C. T. Whitmell M.A., F.R.A.S.

On Saturn, except at an equinox, the boundaries of the ring-shadow are curved either to one pole or the other. Experimenting with a model, I find that both outlines are so curved as to be concave to the pole of the hemisphere receiving them, when the shadow is so viewed as to suffer as little alteration as possible. Calculation confirms this result.

Let l l' be the saturnicentric latitudes of the earth and the sun. Denote the shadow curve of the outer edge of ring A by the letter a, that of the inner edge of ring B by the letter b, ring C is not considered.

Remove the entire ring, but suppose its shadow to be painted upon Saturn, so that we may regard it as visible both from the sun and the earth. Let Saturn be at opposition. Let the earth and sun be in the plane of the planet's equator, so that $l = l' = 0°$; then the shadow appears as a narrow semicircular strip along the equator. The edges seem practically straight and parallel to the equator.

Now let the sun move N. in saturnicentric latitude, the shadow moves S., becomes broader, and its edges become curved. Whatever N. latitude the sun reaches, the shadow outlines will appear curved concave to the S. pole, if we suppose them viewed from a suitable position in the plane of Saturn's equator.

But, when the sun approaches the solstice latitude, a falls outside the planet. Also, it should be noted that, as l and l' cannot actually differ by more than about 3°, and this only near an equinox, it is not possible for the earth to be in the equatorial plane when the sun is more than 3° N. or S. of it.

Now, if the shadow could be seen from the sun (in N. lat.), it would always appear curved convex to the S. pole, though its actual shape on the planet is concave to that pole. We may add

here that the curves do not extend half way round the planet, unless the sun is in the equatorial plane.

Now place the earth in line with the centres of the sun and Saturn, both l and l' being positive (N. lat.). The painted shadow curve a will appear equally convex to the S. pole, both from earth and sun, and so also will b.

Raise the earth above the sun, *i.e.*, make $l > l'$, the curves, as seen from the earth, will be more convex to S. pole, while, if we make $l < l'$, they will be less convex than they are when seen from the sun. If the convexity, as seen from the sun, is not great, this convexity may be changed into a concavity for the earth-view, by sufficiently decreasing l. For example, let $l' = 3°$, and $l = 0°$, then the curve is concave to the S. pole for the earth, though convex for the sun.

On investigation it will be found that the shadow curve is not a plane curve (except at an equinox), so that it cannot (except at an equinox) be projected from the sun into a straight line upon the planet's disk.

When the earth is the view point the changes from convexity to concavity are accompanied by points of inflexion.

Consider a the curved shadow of the outer edge of the A ring. Let $l' = +\ 3°\ 6'\ 50''$ and remain constant.

If $l = l'$, the curve from both sun and earth is convex throughout to S. pole, and is truly elliptic.

Lower the earth so that $l = +2°\ 36'\ 56''$, then to the earth, the two end portions of the curve will become nearly straight, the middle part remaining convex to S. pole. Put $l = +2°\ 16'\ 10''$, the two ends become concave to S. pole, the middle being still convex, though less so than before. Put $l = +\ 1°\ 55'\ 44''$, the concavity of the ends increases, and the middle is now nearly straight. Put $l = +0°\ 24'\ 47''$ the whole curve is now concave to S., and will be still more concave if $l = 0°$, or is negative. As l decreases, points of inflexion travel along the curve from its ends towards the centre. *See* Fig. 1.

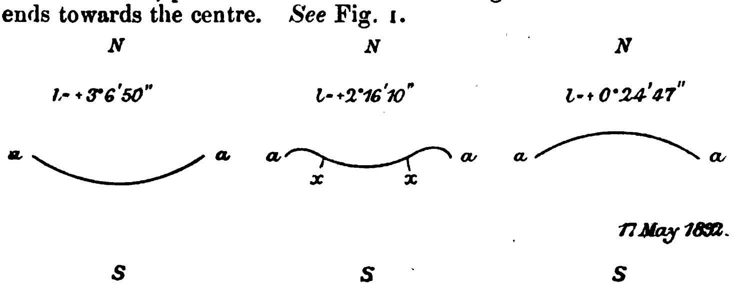


FIG. 1. Ring, N. of shadow. $l' = +\ 3°\ 6'\ 50''$, constant.

$a\ a$ is shadow-arc of outer edge of Ring A, $x\ x$ points of inflexion. Curves exaggerated and simply diagrammatic, to show changes in curvature of a, as l diminishes. (For the third curve, *see* "Memoirs," British Astronomical Association, Vol. II., Part I., Plate, lowest sketch, No. 6.)

The condition $l = +\ 0°\ 24'\ 47''$, $l' = +\ 3°\ 6'\ 50''$, actually occurred on 17th May 1892, and the shadow a was then seen by Mr. MacEwen, concave to the S. pole. (*Cf.* Memoirs, British Astronomical Association, Vol. II., Part. I., p. 23 and Plate. Report on Saturn Section by the late Rev. A. Freeman.)

On 2nd February 1862 the earth was just S. of the Ring, and, for the sun, $l' = -1^\circ\ 37'\ 23''$. Both *a* and *b* were then visible concave to the N. pole. (*Cf.* Proctor, "Saturn and its System," Plate I., Fig. 1.) *See* Fig. 2.

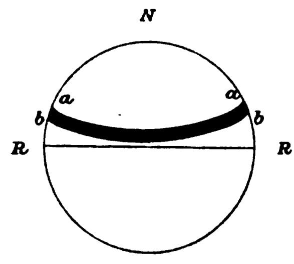


FIG. 2 $l' = -1^\circ\ 37'\ 23''$, l just south.

a b both seen concave to N. pole. R R, the ring S. of shadow, 2nd February 1862. (Curves much exaggerated.) *a a, b b*, are the shadow-arcs of rings A. and B. (*See* Proctor's "Saturn and its System," Plate I., Fig. 1.)

When $l' = +3^\circ\ 6'\ 50''$ I find the following values for the positions of some points where the shadow curve *a* falls on Saturn, supposed spherical, with radius = 38,000 miles. The radius of ring A is taken as 84,000 miles. Longitudes are reckoned E. and W. from a vertical plane through the centres of the sun and Saturn.

Longitudes E. and W.	South Latitudes.
° ′ ″	° ′ ″
0 0 0	3 46 58
49 19 3	4 27 12
89 39 50	6 8 51

The last value is the limit, when the sun ray becomes tangential to the planet. These data show that the shadow curve on Saturn is concave to the S. pole.

Next consider *b*, the shadow of the inner edge of ring B. seen within the ring. Put $l' = +1^\circ\ 37'\ 23''$, and suppose this to remain unaltered. Let $l = +4^\circ\ 37'\ 23''$, then the convexity of *b* to S. pole, as seen from the sun, is increased when it is seen from the earth. Imagine now that *b* can still remain visible, even when l is less than l'. Put $l = +0^\circ\ 33'\ 50''$, the curve will seem almost straight. Put $l = 0^\circ$ and *b* becomes concave to S. pole. Put $l = -1^\circ\ 37'\ 23''$, the curve is now really in sight, and its concavity S. is increased. The shadow now falls on what seems to be the upper half of the planet's disk, though strictly *b* is, of course, in the southern hemisphere.

At the N. summer solstice, $l = 26^\circ\ 49'\ 30''$, and I then find the following values for the positions of some points, where *b* falls on Saturn. The radius of the B ring is taken as 56,000 miles, and the planet is supposed spherical. Longitudes are reckoned E. and W. from a plane through the sun and Saturn's axis.

Longitudes E. and W.	South Latitudes.
° ′ ″	° ′ ″
0 0 0	14 51 33
31 45 54	16 46 35
57 42 10	22 30 7
73 33 20	29 14 28

The last value is the limit for sun rays tangential to the planet. We notice again that the curve on the planet is concave to the S. pole.

Seen from the sun the curve b would of course appear decidedly convex to the S. pole. At and near a solstice, l differs so little from l' that the curvature of the shadow, as seen from the earth, will not perceptibly differ from its curvature supposed seen from the sun, and so will appear distinctly convex to the S. pole. Could we put the earth 4° lower than the sun, and imagine the ring not to hide b, then concavity would begin to appear at the ends of the curve, and the whole curve would become distinctly concave, S. if seen from the plane of the equator, as it might be from another planet. Before the solstice is reached, shadow a (of A ring) falls outside the planet, and so is lost in space.

Restricting the description to what is actually visible, we may put the matter as follows:—

Suppose the sun in a low N. latitude, and that we keep it fixed while shifting the latitude of the earth. From the sun, the curves of A and B would be seen, both convex to the S. pole. The ring would hide its own shadow. Now place the earth so that $l > l'$; we see, within ring B, the shadow b, and its curvature to S. pole is more convex than that of B, seen from the sun. The shadow a will generally be hidden by the ring.

Lower the earth, and the convexity of b begins to lessen. When $l = l'$ no shadow a or b can be seen, but only the ring edges themselves, curved as when seen from the sun.

Thus the curve b, when actually seen from the earth, is always more convex than curve B, seen from the sun. Now take l a little less than l'. The shadow b remains invisible, but a now appears on the planet outside the A ring, and has a convexity to S. less than that of A, seen from the sun. Continue to lower the earth and the convexity of a lessens, disappears, and is replaced by a curve concave to S. Thus, the curvature of a, seen from the earth, is always less convex than the curvature of A from the sun. With l less than l', shadow b would generally be hidden by the ring. If the sun is in the equatorial plane, the shadow curves will appear concave to S. pole, if earth is S., and concave to N. pole if earth is N. of the equator.

The foregoing may be summed up thus:—

If l and l' are of the same sign, and $l > l'$, shadow b is seen inside the ring, but a is not seen as a rule. If $l < l'$, the latter is seen outside the ring, but the former is not seen as a rule. If $l = l'$, neither is visible. If l and l' are of opposite sign, both a and b may be seen inside the ring, which will itself be unlit by the sun.

But, even when l and l' have the same sign, it is possible (near an equinox, l' being less than 2°, and l distinctly greater than l') to see both a and b within the ring system.

Also it is possible, with l and l' of the same sign (near an equinox, l being less than 2°, and l' distinctly greater than l) to see both a and b outside the ring system. This was the condition on 2nd February 1862. Of course, in both these cases, the breadth of the shadow strip is very small. *See* Fig. 2.

Equations to the shadow curve on the planet. Let θ be the saturnicentric latitude of the sun, R and S the radii of the ring, and of Saturn, R being the radius either of A or B. Saturn is supposed spherical. Take the centre of Saturn as the origin of co-ordinates, and the axis as the axis of z. Let plane of ring be plane xy, the plane through Saturn's axis and the sun be plane xz, and the plane perpendicular to these planes be plane yz. Then—

$$z = \sqrt{(S^2 - y^2)}\text{sine}\left\{\theta - \text{sine}^{-1}\left[\frac{\sqrt{(R^2 - y^2)}}{\sqrt{(S^2 - y^2)}}\text{ sine }\theta\right]\right\},$$

$$x = \sqrt{(S^2 - y^2)}\text{cosine}\left\{\theta - \text{sine}^{-1}\left[\frac{\sqrt{(R^2 - y^2)}}{\sqrt{(S^2 - y^2)}}\text{ sine }\theta\right]\right\},$$

are the equations to the curve.

These equations are those of a curve of double curvature. It is easy to see that the ratio $\frac{z}{x}$ increases as y increases, and thus the actual shadow curves on Saturn are concave to the pole of the hemisphere receiving them.

The sun's rays, grazing the inner and outer ring edges, form parts of hollow elliptic cylinders, which meet the sphere of Saturn in curves of double curvature, and these form the shadow boundaries a and b. From the sun these boundaries are truly elliptic, being projections of elliptic cylinders on to a plane perpendicular to the Saturn-sun line. The vertex of a shadow-arc is at one end of the minor axis of an ellipse, whose major axis is the diameter of the ring, the minor axis being equal to this diameter $\times$ sine θ.

From the earth the shadow arc is seen projected on to a plane perpendicular to the Saturn earth line, and hence is not truly elliptic, except when $l = l'$, and then the arc coincides with the ring-edge, and so is invisible.

With $l > l'$ shadow b will appear more convex than ring B. With $l < l'$ shadow a will appear less convex than ring A, will present points of inflexion, and finally become concave as l diminishes, provided that the values of l and l' are sufficiently small, and their difference is sufficiently great.

Correspondence.

Tempel's Comet 1873 II.

The Members of the Association will be pleased to learn that a very successful series of observations of the periodical comet Tempel 1873 II. has just been completed at my observatory. On 27th June last a letter was received by me from Mons. L.

Schulhof, of the Paris Observatory, who has charge of the investigations into the movements of this interesting object, requesting that the comet might be observed as long as possible. My first observation was obtained on July 2, and by means of the 8-in. equatorial refractor and square bar-micrometer, it has been observed on every occasion, when the moon and the weather permitted, down to the 7th instant. In that period the comet's position was fixed on 43 nights, during which 51 comparison stars were employed and 413 comparisons obtained. On the 7th instant the comet was of the last degree of faintness. The moon then interfered with the work, and it is not at all probable that any further observations can be obtained after the moon again leaves the sky. I trust the observations already secured will prove useful in the discussion which Mons. Schulhof has in view. He states that the present opportunity will be an exceptionally favourable one for the determination of the mass of the giant planet Jupiter. The local observations of Winnecke's Comet, in 1886, turned out useful for a similar investigation by Dr. von Haerdtl, of Innsbruck.

Observatory, Peninsula, Windsor. JOHN TEBBUTT.

Ariel and Umbriel.

A few years ago I found it necessary to refer to these two satellites of Uranus, discovered by the late Mr. Lassell. Ariel was a well-known name, but where did Mr. Lassell find the name Umbriel? Two instances only need be given where the name Ariel occurs. One of these, and probably the first known one, is where the name Ariel is mentioned in the Bible as one of the strong men who went up from Babylon to rebuild the Temple at Jerusalem. It would, no doubt, be possible to give many more references in which the name Ariel is referred to, but only one other will suffice. In the "Tempest" the following reference to the name Ariel occurs. I am obliged to quote from memory, as, to use the phrase of a certain other Member of the Association, "I am miles away from my library." The Duke says, "What ho, my gentle Ariel. Haste thee to the king's ship." Ariel replies, "I go and return ere thou canst breathe twice."

As to Umbriel I found great difficulty. I wrote to M. Flammarion on the subject. M. Antoniadi replied that M. Flammarion did not know. I then inserted a question on the subject in "Notes and Queries." Mr. Lynn answered the note, but could give no information either as to where the name came from. It does not seem to be in any of our best dictionaries. I knew before I made these inquiries that the two names, Ariel and Umbriel, occur in Pope's "Rape of the Lock," where he terms Umbriel a "dusky sprite." So far as my present information goes that appears to be the first mention of the name "Umbriel" in our language, and it would rather appear as if it had been coined by Pope for the occasion. As I shall shortly have occasion again to refer to the name, I wrote to Miss Lassell, asking if that lady could give any information as to where Mr. Lassell

got the name. Miss Lassell very kindly answered my letter. As this is a matter connected with the history of astronomy, and it does not appear that the information her letter contains is generally known, I asked, and obtained her consent to make it public. The letter is in the following terms :—

DEAR SIR, 25th October 1899.

IN reply to your query as to the occasion of one of the satellites of Uranus being called "Umbriel," I may say that the name was given by Sir John Herschel, to whom my father applied in order that there might be some distinctiveness to separate these satellites from those that Sir W. Herschel had been supposed to discover, inasmuch as their periods did not agree with any of those four mapped out by Sir William.

Sir John fixed upon the names "Umbriel" and "Ariel" because they were difficult to see, and the one was much darker than the other. I have no doubt the name was taken from Pope's writings, but I do not recollect that this was positively so. Anyhow, the two names quite fit the two satellites, and their names are quite of a similar class.

I trust my reply is satisfactory.

I remain, &c.
"JANE LASSELL.

In a subsequent note Miss Lassell states that she has been unable at present to find Sir John Herschel's letters on the subject as they have been laid aside owing to removal of residence.

It will be seen from what has been stated, that so far as we yet know, Pope appears to be the author of the name "Umbriel." It may, however, be that some Member of the Association can give a different and older reference to the name, and if such a reference is found, it is hoped it will be published in this "Journal."

W. FORGAN.

Occultations observed during the Lunar Eclipse, June 1899.

Though the observation of lunar eclipses is not attended with the same amount of concern as solar ones, still for amateur astronomers considerable interest attaches to them, especially when they are total, for then the duration is lengthy, and observers may occupy themselves variously, as in searching photographically for a second moon, noting the colours of the moon as the penumbra and umbra pass over it, recording times of occultations, &c.

For the use of Mr. John Tebbutt, F.R.A.S., a number of occultations during the lunar eclipse of June 23, 1899, were computed by Mr. C. J. Merfield, F.R.A.S., who also communicated them to the New South Wales Branch of the British Astronomical Association, thinking that, although the times were computed for Windsor (a town 34 miles west of Sydney), they

might be useful to the Members. Availing myself of this kindness, I made the following observations:—

No.	Star.	Mag.	Greenwich Mean Time.	Phenomenon.
			h. m. s.	
1	Z.C. 369 - -	7·5	1 14 51	D.
2	C.P.D. 23°6961 -	9·7	1 41 30·5	D.
3	C.P.D. 23°6967 -	10·0	1 50 50	D.
4	C.P.D. 22°6851 -	9·8	2 9 51·6	D.
5	Z.C. 492 - -	8·5	2 14 52·3	D.
6	Z.C. 397 - -	8·5	2 42 13·1	R.
7	Z.C. 538 - -	8·5	2 45 13·8	D.
8	C.P.D. 23°6961 -	9·7	2 53 10·1	R.
9	Z.C. 417 - -	9·0	2 54 25·6	R.
10	C.P.D. 23°6956 -	9·4	2 55 30·6	R.
11	C.P.D. 23°6969 -	10·1	3 4 47·1	R.
12	C.P.D. 23°6970 -	10·2	3 4 47·1	R.
13	Z.C. 473 - -	9·5	3 7 57·1	R.
14	Z.C. 478 - -	9·5	3 19 45·6	R.

Z.C. = Cordoba Zone Catalogue; C.P.D. = Cape Photo-Durchmusterung; D. = Disappearance; R. = Reappearance. The necessary corrections for the chronometer's rate have been made.

Observations 1 and 3 were made through haze as rifts appeared in the fast driven clouds. For over half an hour during the early part of the eclipse, the moon could hardly be seen for clouds; but later on the atmospheric conditions became very favourable. On looking over my list, Mr. Merfield suggests that No. 3 has been wrongly identified, and should be C.P.D. 23°6966.

The observations were made by the eye and ear method. The telescope used is an 8½-in. reflector, with eye-piece magnifying 65. A chronometer, ticking half-seconds, that had been specially rated during the month by time signals with the Sydney Observatory was used throughout the night.

Mr. Geo. Butterfield assisted me, and I have to thank him for a wrinkle which may be useful to other young astronomers. Before uncovering the telescope, the predicted occultations were numbered consecutively, and using a protractor, on a map of the moon was boldly marked in lead pencil at the angles of disappearance and reappearance, the number of the occultation. This considerably facilitated observation and identification of the stars, which in our particular case was necessary, as the moon was in the Milky Way, and numerous stars were seen to be occulted, but whose times had not been computed by Mr. Merfield. As a spectacular phenomenon the eclipse was more picturesque through a pair of binoculars than through the telescope.

Neutral Bay, Sydney. HUGH WRIGHT.

The Late NATHANIEL E. GREEN, F.R.A.S.,

President, Oct. 1896 to Oct. 1898.

In Memoriam.

Nathaniel E. Green, F.R.A.S.

Our Members will have learned from the brief notice in the last number of the "Journal" of the sad loss which the Association has sustained in the death of our late President, Mr. N. E. Green. He was so intimately connected with the Association from its foundation, so well known and so much respected, that a brief account of his life and work cannot fail to be welcome, especially to those who were able to attend our Meetings, and who will miss his once familiar face.

Mr. Green was born at Bristol, on August 21, 1823, being the third son of Benjamin H. Green, of that city. He was educated chiefly by his maternal uncle, the Rev. C. Everett, and in 1840 commenced life in a merchant's office in Liverpool. Finding a commercial life uncongenial to him, and having a great love for drawing, he eventually decided to adopt art as his profession, and came to London in 1844, entering the Royal Academy as a student in December of that year. Here he worked side by side with Leighton, Millais, and Rossetti. In 1847 he married Elizabeth Goold, of Cork, and after living for about a year in the West of London, eventually settled in St. John's Wood, where he resided for 49 years, attracted to the neighbourhood by its quiet retirement, and its favourable surroundings for the pursuit of his artistic and astronomical studies. For some years he was a constant exhibitor at the Royal Academy and other galleries, painting both in oil and water colours, but the pressing needs of a large and growing family led him early to adopt teaching as a profession. In this he was eminently successful, and gained a wide-spread reputation. In 1880 he was called to Balmoral, where he had the honour of numbering amongst his pupils, Her Majesty, the Princess of Wales, and other Members of the Royal Family. He was the author of many works on art, principally manuals and other works of a practical kind, which have had a wide circulation.

In 1884 he visited Palestine, where some of the best of his water-colour drawings were made. A succession of dreary winters in London drove him, in 1890, to seek summer skies for his artistic work, and for this cause, as well as for the benefit of his wife's health, he selected Cannes as his winter home. During the six seasons spent there he formed a wide circle of friends, continuing the pursuit of his art till his last visit in 1898–99.

His interest in astronomy dates back to 1859, when he constructed a telescope for himself, and began the long series of observations and drawings which he continued to make till within a year and a half of his death. In 1877, on the occasion of the favourable opposition of Mars, Mr. Green undertook a voyage to Madeira, and there, during August and September, he made the series of admirable drawings of the planet with which his name will always be associated. Their truth and the delicacy of their execution have been so often remarked upon that praise

would be superfluous. The foreshortening of the details of the planet's surface as they approach the limb is so perfectly rendered that one feels that it is truly a sphere, and not a flat disk, as it too often appears in other representations. Of the 41 sketches made of the planet with a 13-in. Witt reflector, 12 were reproduced in his Memoir (Mem. R.A.S., Vol. XLIV.), as well as enlarged drawings of the south polar cap, and a map of the planet. He did not see any "canals," and mentioned his impression that the mind was inclined to prolong into a line any elongated dark spot that was imperfectly seen, or to represent by a definite line what was in reality merely the edge of a faint shading.

At the less favourable opposition of 1886, Mr. Green made further studies of Mars, with a map of the northern hemisphere. These were not published, but several of his sketches, and a map of the planet constructed from them, are in the rooms of the Royal Astronomical Society.

He published an important memoir on Jupiter in Mem. R.A.S., Vol. XLIX., giving the results of a series of observations dating from 1859 to 1887. The memoir deals with the general changes on the planet from 1860 to 1887; the Red Spot, 1881 to 1886; the relative altitudes of light and dark markings; and concludes with some considerations on the probable physical condition of the planet. The memoir is illustrated by a series of beautiful drawings.

In the "Journal" of the Selenographical Society (of which Society during its brief existence Mr. Green was an active member) he published a long series of papers on lunar formations, as well as observations of Hyginus N., accompanied by drawings.

Mr. Green was a Member of the Provisional Committee of the British Astronomical Association, and sat on its first Council; was Director of the Saturn Section in 1891, and also in 1895–98. A report of the Section was published in "Memoirs," British Astronomical Association, Vol. II., but his enforced absence from England during the winter compelled him to leave the more active work to the Vice-Director, the late Rev. A. Freeman. Shorter reports of the Section were published in our "Journal," Vols. I., VII., and VIII. Mr. Green was Vice-President of the Association in 1892–93 and 1898–99, and President in 1897–98. In the first volume of the "Journal" is a suggestive paper by him on lunar maria and their possible origin; and in the third volume is a report of an admirable practical lecture on astronomical drawing. In this lecture he mentions that it had been said of him that he preferred an artistic drawing to a correct one, and he characteristically replies, "I know no difference between the two."

In 1896 Mr. Green joined the British Astronomical Association Eclipse Expedition to Norway, and it is much to be regretted that the unfortunate weather prevented the use of his skilful pencil in the delineation of the corona.

He was elected a Fellow of the Royal Astronomical Society in 1875, and sat on the Council for the year 1888–89.

Mr. Green was a type of the best kind of amateur observer. Possessing great skill in drawing he wisely devoted himself to observations in which his keen sight and true hand enabled him to

secure results of permanent value. For a period of nearly 40 years he continued his astronomical work with unflagging perseverance. His profession often claimed him from 8 o'clock in the morning till 7 in the evening. After a light meal he would commence work with the telescope, often prolonging his study far into the night; on unfavourable evenings he would work with equal assiduity with the microscope.

Besides his published drawings Mr. Green left behind him a great number of sketches of various lunar formations, of Saturn and of Mars, and a long series of drawings of Jupiter.

Not long before his death Mr. Green had taken a house in St. Albans, where he died after a very short illness on the 10th of November, at the age of 76. His widow survives him.

Notes.

The Late Rev. E. L. Berthon, M.A., F.R.A.S.—We regret to record the death of this well-known inventor at the advanced age of 86. Born in 1813, on leaving school Mr. Berthon spent five years in Liverpool and three in Dublin, in the study of medicine. For some reason not explained his engagement to Miss Preston put an end to his medical studies, and after travelling with his wife on the Continent for some years, Mr. Berthon went to Cambridge in 1841, where he took a pass degree, and as he says, "resisted all persuasions to go in for honours." On leaving college he took Holy Orders, and was eventually presented with the living of the Abbey Church at Romsey. His name is much connected with the restoration of this Norman church, but his chief claim to fame lies in his invention of the "Berthon Collapsible Boat," which owed its origin to the wreck of the "Orion" off Portpatrick. His favourite hobby, however, was astronomy, and the construction of astronomical instruments, and many will recollect his re-admission in June last as a Fellow of the Royal Astronomical Society, when he showed his new form of equatorial telescope. He joined the British Astronomical Association in March 1899, and we very greatly regret that we should have retained him as a fellow Member for so short a time.

The Royal Astronomical Society.—The Society met in Burlington House, on Friday, 1899, November 10, the *President*, Prof. G. H. Darwin, in the chair. The *President* recorded the death of the Rev. E. L. Berthon since the last Meeting, and the *Secretary* read the list of presents received, which included volumes from the Cape and Harvard Observatories, a part of Prof. Weinek's "Photographic Atlas of the Moon," and some photographs of nebulæ taken by the Crossley reflector at the Lick Observatory. Three papers were then read connected with the stars on the Astrographic Catalogue. The first, by *Mr. F. Bellamy*, gives curves showing the distribution of stars on plates

taken at Greenwich, Oxford, Paris, and Potsdam, where it was seen that the Greenwich curve did not accord with the others, a discordance partly accounted for by the small galactic latitude of the Greenwich plates. *Mr. Dyson* and *Mr. Hollis* read a paper "On a Comparison of Diameters of the Images of Stars on the "Greenwich Astrographic Plates with the Magnitude of the "Bonn Durchmusterung." Its object was not to obtain a law for the determination of magnitude from diameter, but to show the variations from plate to plate. *Mr. Hollis* said that a photographic plate could not be used as accurately as a photometer, though it might be used roughly as such. He also pointed out that the *blueness* of the fainter stars caused a greater number to appear as 9·5 mag. on the plate than in the B.D. Catalogue. *Prof. H. H. Turner* next spoke of a systematic error, depending on the magnitude of a star, that has been recognised of recent years in meridian observations, and he pointed out that the amount of this error might be determined from the photographic plate. *Mr. Dyson* asked Mr. Bellamy if the ratio of the number of stars per square degree on the plate and visually observed, is constant down to mag. 9 for the dense and sparse portions of the sky, and *Mr. Franklin-Adams*, *Prof. Turner*, and *Mr. Dyson* joined in a discussion on the best methods of illuminating the field. *Mr. Wesley* showed on the screen the photographs that had been sent to the Society by Prof. Keeler, and then *Mr. Knobel* took the chair whilst *Prof. Darwin* read an interesting and learned paper "On "the Theory of the figure of the Earth carried to the second order "of small quantities." *Dr. Johnstone Stoney* asked if the earth's figure showed an inequality in longitude, and *Prof. Turner* asked as to the value of pendulum observations of which, he said, Major Defforges had but a poor opinion. *Dr. Johnstone Stoney* then addressed the meeting on the subject of the expected Leonid meteors and explained the position of the meteor-orbit in space.

PHOTOGRAPHS OF STARS, STAR CLUSTERS, AND NEBULÆ.—Dr. Isaac Roberts' second volume is about to be issued from the publishing office of "Knowledge." It will contain 72 photographs beautifully reproduced by the collotype process, in addition to many pages of text. Only a limited number of copies of the work will be available for the public.

"THE HEAVENS AT A GLANCE."—This almanac, by Mr. A. Mee, is now obtainable for 1900, and will doubtless be as welcome as were those for this and past years. With this useful card hanging in the observatory or study, no astronomer need fear to miss watching for any striking celestial phenomena which may be due, be it an eclipse, meteor shower, maximum of some interesting variable, or favourable apparition of a planet.

MESSRS. W. WESLEY AND SON'S CATALOGUE.—The present catalogue is a new edition of Messrs. Wesley and Son's Astronomical Circular (No. 124) issued in 1895. It is well worth preserving, and deserves to rank as a bibliography of astronomical literature. Messrs. Wesley promise to publish early in 1900 a bibliographical catalogue of the scientific literature of the times previous to those of Laplace, of which they have a large collection of books and manuscripts.

A New Observatory.—Our Fellow Member, Señor J. Comas Solà, has just inaugurated his private observatory, Sant Felip, 29, Sant Gervasi, Barcelone; N. lat. 41° 24′ 2″, E. long. $8^m\ 35^s\cdot2$. It possesses a Grubb equatorial of 6 inches aperture.

Comet Notes. —Giacobini's Comet (*e* 1899) was observed by Signor Cerulli at Teramo on November 3 and 10, the place agreeing closely with that given by Winther's elements. We continue his ephemeris, which is for Berlin midnight. (**A.N.**, 3602.)

Date.	R.A.	N. Dec.	Date.	R.A.	N. Dec.
	h m s	° ′		h m s	° ′
Dec. 18 -	18 35 13	17 29	Dec. 30 -	18 56 37	21 16
22 -	18 42 17	18 43	Jan. 3 -	19 3 53	22 35
26 -	18 49 25	19 59	7 -	19 11 13	23 55

At the end of December, the brightness is only one-third of that at discovery; the comet will, therefore, probably be invisible in small telescopes.

Prof. Barnard observed Holmes' Comet (1899 II.) on October 30 and November 4; the correction required by Zwiers' corrected elements being + $0^s\cdot77$ in R.A., + $8''\cdot8$ in Decl. (**A.N.**, 3604.) An ephemeris of this comet up to January 1 will be found in the last number of the "Journal."

The following observations of Tempel's Second Periodic Comet were made by Mr. John Grigg at Thames, New Zealand.

G.M.T.	R.A.	S. Dec.	G.M.T.	R.A.	S. Dec.
d	h m s	° ′	d	h m s	° ′
Aug. 31·801	21 32 20	35 26	Sept. 20·830	21 59 55	35 50
Sept. 5·885	21 38 45	36 0	21·880	22 1 40	35 43
10·821	21 46 0	36 12	22·827	22 3 30	35 36
11·827	21 47 35	36 13	25·821	22 7 55	35 14

He notes that it was very faint and difficult to observe.

B.A. for November contains a discussion of the orbit of Finlay's Periodic Comet for the three returns 1886, 1893, 1899. The following are the elements for 1899:—

Epoch 1899, October 16·0. Paris M.T.

$$\begin{aligned} M &= 341^\circ\ 24'\ 7'' \\ \left.\begin{aligned} \omega &= 315\ \ 40\ \ 50 \\ \Omega &= \ \ 52\ \ 23\ \ \ 7 \\ i &= \ \ \ \ 3\ \ \ \ 2\ \ 54 \end{aligned}\right\} & 1899\cdot0. \\ \phi &= \ \ 46\ \ 19\ \ 22 \\ \mu &= 541''\cdot235. \end{aligned}$$

There is, unfortunately, no hope of seeing the comet at this return as it is very unfavourably placed. But at the next return,

in August 1906, it will be only some 18 millions of miles from the earth, and should be conspicuous. After that it will make a close approach to Jupiter and the orbit will be considerably modified.

The same publication contains an interesting article by M. L. Picart on the method of deducing a parabolic orbit from three observations of a comet without any previous assumption as to its distance being required. The article is very clearly explained and should be studied by all who contemplate taking up the computation of cometary orbits.

There is in the same publication a list of all the principal works dealing with the computation of orbits from Newton to the present day.

A.S.P., No. 70, states that Comet 1898 VII. (Coddington) was followed at the Lick Observatory till 1899, September 7, a period of 15 months. Its distance from the sun at the last observation was 4·46, and its brightness about 15th magnitude.

Ap. J. (October) contains an article by W. H. Wright on observations of Comet spectra. Comet 1898 I. (Perrine), 1898 VII. (Coddington), 1898 X. (Brooks), were all of the usual type, viz., a faint continuous spectrum with the three characteristic bright bands. The continuous spectrum in the third comet was, however, very weak, as was also the case in the spectrum of 1899 I. (Swift), which consisted almost entirely of bright lines. A correcting lens was placed in front of the slit, and some very satisfactory photographs of the spectrum secured. The three carbon bands (possibly also a fourth and fifth) are shown; other bands in the spectrum are considered to be due to cyanogen.

A.N. 3602 contains the following hyperbolic elements of Comet 1899 I. (Swift), computed by C. J. Merfield from 59 observations extending from 1899, March 4 to July 12:—

$$
\begin{aligned}
T &= 1899,\ \text{April},\ 12{\cdot}97772.\quad \text{Greenwich M.T.} \\
\left.\begin{aligned}
\omega &= 8^\circ\ 41'\ 55''{\cdot}7 \\
\Omega &= 24\ \ 59\ \ 18\ {\cdot}3 \\
i &= 146\ \ 15\ \ 27\ {\cdot}7
\end{aligned}\right\} & \ 1899{\cdot}0 \\
\log q &= 9{\cdot}513975 \\
e &= 1{\cdot}000395
\end{aligned}
$$

There is also an article by Dr. Schobloch on the resemblance of the orbits of Comets 1881 IV. and 1898 X. Both orbits make fairly close approaches to that of Jupiter, and he suggests that the comets may have originally had a common elliptical orbit, which has now been transformed into a sensibly parabolic one by the action of Jupiter.

The same publication contains notes by Mr. Perrine on his investigation of the refractive effect of Swift's Comet on stars over which it passed. The displacement of the stars was inappreciable.

MINOR PLANET NOTES.—A new planet EX was discovered by Mr. Coddington, at the Lick Observatory, on October 2. It belongs to the group of planets whose period is about half that of Jupiter.

A LONG PHOTOGRAPHIC TELESCOPE.—Prof. Pickering has received the necessary funds from anonymous donors, and expects that a telescope with 12 inches aperture, and a focal length of 100 feet or more, will be ready for trial at the Harvard Observatory in a few weeks.

REPORT OF THE BOARD OF VISITORS TO THE UNITED STATES NAVAL OBSERVATORY, 1899, OCTOBER 2.—The Board specially appointed to consider various questions in connexion with the organisation and work of the observatory consisted of the Hon. W. E. Chandler, A. G. Dayton, and Professors E. C. Pickering, G. C. Comstock, G. E. Hale. They do not recommend a severance of the connexion with the navy, but they think that a civilian astronomical staff should be appointed, consisting of a director, four astronomers, three assistant astronomers, with computers and minor officers. A director of the "Nautical Almanac" should also be appointed, and a board of visitors, consisting of six astronomers of high standing, and three eminent citizens, the board reporting to the Secretary to the Navy. A scale of salaries is suggested for astronomers appointed from civil life, and the desirability is urged of providing dwelling quarters in the grounds for all the staff regularly assigned to night work.

THE CROSSLEY REFLECTOR.—This mirror, originally made by Calver, was used by Dr. Common to obtain the photographs for which he received the gold medal of the Royal Astronomical Society in 1884. It was afterwards acquired by Mr. Crossley, and by him presented, after some alteration, to the Lick Observatory. The mirror, which has a very fine figure, has an aperture of three feet, and a focal length of 17 feet 6 inches. The photographic power of the reflector is illustrated by the photographs of nebulæ recently taken, some of which were exhibited at the November Meeting of the British Astronomical Association. With exposures of four hours, stars and nebulæ are photographed which are far beyond the range of the 36-in. refractor.

Notices of the Association.

The ordinary Meetings of the Association will be held on 1899, December 27; 1900, January 31, February 28, March 28, April 25, May 30, and June 27.

The Council.

The Council desire to inform the Members of the Association that they have appointed Capt. W. Noble, J.P., F.R.A.S., Vice-President in the place of the late Mr. N. E. Green, F.R.A.S., and Miss Gertrude Bacon to be Member of the Council in the place of Capt. Noble, in accordance with Rule No. V., clause 8.

Eclipse Expedition, May 28th, 1900.

Provisional arrangements have been made with the Royal Mail Steamship Company for the engagement of R.M.S. "Clyde," 5,654 tons, 7,010 h.p., to convey the Members of the proposed expedition to Cadiz, Alicante, and Algiers. The steamer is timed to leave Southampton at 6 p.m. on Friday, May 18th, 1900, and to reach Algiers at 6 a.m. Thursday, May 24th. It is due to reach Southampton on its return at 7 a.m. on Monday, June 4th. A plan of the steamer, with prices of berths, will be on view on December 27th, at the Meeting of the Association, when further particulars will be given. A circular with a complete programme will be issued shortly.

Queries.

It is requested that queries be written on one side of the paper only, and each query on a separate sheet.

Queries may either be placed in the Query Box at the Meeting, or may be sent to the Hon. Secretary, Mr. W. Schooling, F.R.A.S., Fairholme, Christchurch Road, Surbiton.

Candidates for Election as Members of the Association.

27TH DECEMBER 1899.

ALFRED CONWAY BISHOP,
41, Thurlow Square, S.W.
Proposer—Samuel Barker. *Seconder*—Arthur Kennedy.

SCRIVEN BOLTON,
24, Kensington Terrace, Hyde Park, Leeds.
Proposer—Washington Teasdale.
Seconder—Chas. F. Whitmell.

CAPT. URIAH COOKE,
49, Drakefell Road, Nunhead, S.E.
Proposer—Fredk. Chas. Foster. *Seconder*—Charles Prescott.

HENRY JOHN LLOYD,
11, New Walk Terrace, York.
Proposer—C. T. Whitmell. *Seconder*—Wm. Schooling.

MISS IRENE MAUNDER,
18, Walerand Road, Lewisham Hill, S.E.
Proposer—E. Walter Maunder.
Seconder—A. S. D. Maunder.

WILLIAM NORRIE,
Cairnhill, Turriff, Aberdeenshire.
Proposer—John McDougal Field.
Seconder—Charles F. Smith.

WILLIAM THOMPSON, J.P.,
Walton Grange, Stone, Staffs.
Proposer—A. E. Brisco Owen.
Seconder—Thos. Frid Maunder.

HENRY WYLES, L.D.S.,
155, Woodhouse Lane, Leeds.
Proposer—C. T. Whitmell.
Seconder—Henry John Townshend.

New Members of the Association.

ELECTED, 29th NOVEMBER 1899.

Rev. J. G. BENSON, Mill Hill Road, Derby.

MISS J. E. A. BROWN, Further Barton, Cirencester.

W. E. BUCHANAN, care of Messrs. Grindlay, Groom & Co., Bombay, India.

JOHN CHARLES CLARET, 11, Hartham Road, Bruce Grove.

EDWARD THOMAS CROKE, "Innisfallen," Worthing.

FRANCIS JOHN GARRARD, High Holme Road, Louth, Lincolnshire.

Rev. JOHN LAIDLAW, B.D., Free Church Manse, Meethill, Perthshire.

JAMES ROBERTSON JACK, 8, Rose Villas, Romberg Road, Tooting.

Rev. SYDNEY ERNEST MARTIN, 1, West View, West Malvern.

RICHARD PONSONBY MAXWELL, Foreign Office.

SAMUEL REEVES, "Homeside," Boldmere Road, Wylde Green, nr. Birmingham.

RICHARD FRIND ROBERTS, A.C.A., 15, Dingwall Road, Croydon, Surrey.

REGINALD APPLEBY WILSON, Westfield, Armley, Leeds.

North-Western Branch.

NEW MEMBER OF THE ASSOCIATION.

Elected 1st November 1899.

CHARLES NEILD, 19, Chapel Walk, Manchester.

New South Wales Branch.

NEW MEMBERS OF THE ASSOCIATION.

Elected 17th October 1899.

FRANCIS J. BAYLDON, R.N.R., "Wandsworth," Wharf Road, Snails Bay, near Sydney, N.S.W.

SIGNOR ORONZO PRESA, 639½, George Street, Sydney, N.S.W.

Victoria Branch.

NEW MEMBER OF THE ASSOCIATION.

Elected 1st October 1899.

HENRY EDWARD COANE, 70, Queen Street, Melbourne, Australia.

Errata.

Owing to an accidental circumstance the proof of the Report of the Saturn Section which appeared in the last number of the "Journal" was not received until after the publication of the number, and a number of errors thus passed without correction.

The "Journal," Vol. X., No. 1.

Page 22, line 7, *dele* and.
Page 22, line 10, *for* 26° 40′ *read* 26° 45′.
Page 22, line 19, *for* Mr. Townsend *read* Mr. Townshend.
Page 22, line 26, *for* 18″·91 *read* 15″·91.
Page 22, line 38, *for* Maw *read* Main.
Page 22, line 39, *for* Procter *read* Secchi.
Page 23, lines 2 and 3, *for* planet's shadow on the ring *read* ring's shadow on the planet.
Page 23, line 10, *for* plan *read* plane.
Page 31, line 18, *for* connected elements, *read* corrected elements.
Page 31, line 32, *for* + 3″ in December *read* 3″ in Declination.
Page 37, line 5, *for* α Draconis *read* γ Draconis.

New Books and Memoirs.

The Story of Eclipses. By George F. Chambers, F.R.A.S., London: George Newnes, Ltd., Southampton Street, Strand, 1899. Price 1*s*.

This little book is one of the Newnes Series of Useful Stories, of which some two-and-twenty have now appeared, and of which three, besides the present one, are from Mr. Chambers' pen. It may seem a very simple thing to prepare a little manual of this kind, but in reality to do it well demands qualities of an order by no means common, and asks for the greatest judgment, conscientiousness, and care. The present book, however, shows not a few signs of extreme carelessness, and the information is ill-proportioned; whilst that which should have formed the basis of the "Story of Eclipses"—an explanation of the physical problems which they present, and the means employed to solve them—is scarcely even attempted to be given.

Histoire Abrégée de l'Astronomie, by Ernest Lebon. 8vo. 288+vii pp. Gauthier-Villars, Paris, 1899.

This title is somewhat misleading. With its portraits and its supplementary indices of biography, the book contains much that is interesting about astronomers and their contributions to science, but a history of astronomy it scarcely can be called. It may be learned that certain discoveries have been made, with their dates and their authors, but a consecutive story of the development of astronomical knowledge must not be looked for. With regard to instruments, for instance, we find some half-dozen inventions mentioned by name, and one instrument described in detail—the large telescope in process of construction for the Paris Exhibition—but we seek in vain for any account of Greek methods, of Arab observatories, of the introduction of pendulum

clocks, of the difficulties met and overcome in constructing large refractor, &c., &c.

The record of ancient astronomy is scanty to a degree, and not even correct. We are left to suppose that the planets were unknown to the Chaldeans, and the author repeats the familiar error of describing the central fire doctrine of the later Pythagoreans as a heliocentric system taught by Pythagoras, and made public by Philolaus. Ingenious and suggestive as is the real system of Philolaus, it entirely excludes the earth's rotation on her axis and the central position of the sun. Again, the Pythagorean idea of attraction towards the centre of the Universe is not the same as Newton's law of mutual attraction between masses (*see* p. 41). It is not by tracing in the half-inspired guesses of the Greeks some resemblance to modern discoveries that we shall find how much we owe them, but chiefly by examining the truly scientific and fundamental work of such men as Eratosthenes Hipparchus, and Ptolemy (to whom our author does full justice), of Eudoxus and Calippus, who sought—although by means of erroneous assumptions—to systematise observations and enable predictions to be made.

Under Arab astronomers none are mentioned, but Al Mamoun and Albategnius and the great services this nation rendered to astronomy by their discoveries in mathematics, their algebra, and their system of notation, are passed over in silence.

The Hindus, who probably taught the notation to the Arabs, and were astronomers from early times, do not exist for M. Lebon, and he is evidently sceptical about the Chinese.

The treatment of modern and contemporaneous astronomy is very incomplete, and it cannot be considered as brought up to date when the coronium line is referred to as 1474, and 1830 Groombridge as still holding the record among swiftly travelling stars. The significant facts brought to light by modern research regarding the distribution of stars and nebulæ are ignored; variable stars are only casually alluded to, and there is no note of recent observations of Jupiter's physical characteristics. On the other hand, cosmogonic theories are treated with some fulness, and space is found for geodesy and meteorology.

The book is well printed and well indexed, but would be much improved by subdividing the headings of the general index.

Astronomical Publications.

Observations of the Weather Bureau along the Path of the Total Eclipse 1900, May 28. *Prof. Frank H. Bigelow.*—Observations for (i) cloudiness of the whole sky; and (ii) cloudiness of the sky in the neighbourhood of the sun, have been made from May 15 to June 15 in 1897, 1898, 1899, at 99 stations along the path of the shadow in the United States. At many the records are complete, at others observations have been made for only one or two years. A table of the total results for each year is given, and the means of these are also represented graphically. It is very clearly shown that the best conditions are to be found in Eastern Alabama and Georgia, the probability of cloudiness increases towards each coast, and is greatest near the Atlantic. On the coast line the chances are one to three against astronomers, in the interior they fall to one to six. Fuller details are published in the reports of the weather bureau for the three years, and that for 1899 contains much useful information as to position and accessibility for 37 different stations. (P.A., Nov.)

WAVE-LENGTH OF THE GREEN CORONA LINE, AND THE LAW OF ROTATION OF THE CORONA. *W. W. Campbell.*—The problem of the rotation of the corona was undertaken by Prof. Campbell at the solar eclipse of 1898. He selected the green line 1474 K. for the determination of radial velocities at opposite points of the corona in the plane of the sun's equator, using the Doppler-Fizeau principle.

With a powerful prismatic spectograph a short section of the corona spectrum was photographed, including the position λ 5317, hitherto believed to be the place of the principal corona line. By means of an arrangement of screens placed in front of the plate a portion of the Fraunhofer spectrum was also photographed on the same plate, both on the red and the blue sides of the strip of corona spectrum. From the data thus obtained the wave-length of the corona line was deduced; the E. side of the corona giving a slightly different value from the W. The results are:—

For E. side - -	5303·21
For W. side - -	5303·32
Mean - -	5303·26 ± ·15

The difference of the determinations corresponds to a velocity of rotation of 3·1 km. per second, but this is considered to be subject to a possible error of ± 2 km.

Prof. Campbell suggests that the error in the value of the wave length hitherto accepted arose from the observers mistaking the strong chromosphere line at λ 5317 for the true corona line. (**Ap. J.**, 1899, Oct.)

THE SUN.—M. Guillaume continues his account of the state of the sun in the second quarter of 1899 at Lyons. There were 59 days of observations, and 16 groups of spots with a total spotted area of 1,096 millionths, instead of 18 groups and 1,385 millionths in the preceding quarter. Ten groups were south and six north of the equator. It was an extraordinary circumstance that so near the minimum there should have been a fine spot at 6° north latitude. In faculæ there were 27 groups instead of 46. The diminution was almost entirely south of the equator.—(**C.R.** No. 22. 1899, November 27.)

THE SIZE OF THE EARTH'S SHADOW IN ECLIPSES OF THE MOON.—Herr Donitch and Herr Kononowitsch took a series of 28 photographs of the partial lunar eclipse of 1898, July 3, at the Odessa Observatory. Previous eye-observations had given for the increase of the earth's shadow due to its atmosphere the following values:—Von Mayer (1/60), Beer and Mädler (1/50, 1/54, 1/48·6, 1/28·3), Schmidt (1/50, 1/56, 1/52, 1/45, 1/44) Oppolzer (1/40), Brosinsky (1/55). The photographic results seem to give a smaller result than Mayer's. He gives a rule that all photographs should be taken on plates of like sensibility, that the times of exposure should be the same, and that all plates should receive the same development (**A.N.**, No. 3601).

Hippalus and its Surroundings. *E. Walter Maunder.*—This region presents many features which are of peculiar value in determining the relative ages of the different types of lunar formation. A consideration of them leads to the conclusion that the order of their appearance was somewhat as follows:—The general trend of all the formations in a S.W. and N.E. direction probably indicates the lines upon which the earliest lunar configurations were based. Next in time came the great rings, so many of which are ranged on these fundamental lines. Then came the series of subsidences which created the grey plains by causing crevasses from which welled up the liquid matter of the interior, overflowing the depressions, piling up in ridges over the later crevasses, and wrecking the great rings on the borders. On the plains we find the concentric lines of ridges and crevasses, the innermost indicating where the earlier sinkings took place. Then followed the formation of ring plains and craters along the lines of fault and in other weak regions of the crust. Lastly, we find the white streaks which pass over all the preceding formations indifferently. (**Kn.**, December 1899.)

The Seas of the Moon. *L. B. Tappenden.*—Mr. Tepper's theory (page 33, Vol. X. of "Journal"), if accepted, will afford an explanation of the lunar "rays." These markings would be caused by meteors ploughing aside the carbon dust and exposing the surface beneath. The rays should therefore be gradually increasing in number. (**Kn.**, 1899, December.)

The Planet Mercury. *W. W. Payne.*—A summary of Lowell's paper, printed June 1898. The work was carried on during the day, and the planet was followed to within 4° of the sun. Very low powers were used, 135 to 170 on the 24-inch telescope, and 75 to 135 on the 6-inch. In the moments of best seeing the 24-inch showed much more than the 6-inch, but on the average there was little to choose between them, and the relative performance seemed to depend on the particular kind of air waves prevailing at the time. Mr. Lowell does not think there is much difference between fairly normal eyes and those of skilful observers, but that the good is distinguished from the poor observer by "keenness of brain." For measurement the filar was preferred to the double image micrometer as more accurate, Mr. Lowell differing on this point from many astronomers of high position. The rotation period was found to be equal to that of revolution: (i) from a study of the markings; (ii) from a study of the librations. The axis is nearly perpendicular to the plane of the orbit. No signs were found of atmosphere, water, vegetation or organic life; but a number of long narrow markings were discovered, best explained as the results of cooling. (**P.A.**, Nov.)

Jupiter's Fifth Satellite.—Prof. Barnard, as the result of observations made at Lick, and at the Yerkes Observatory, gives the period of revolution as $11^h\ 57^m\ 22{\cdot}647^s$, with an error not greater than $0{\cdot}01^s$. (**P.A.**, Nov.)

THE NORTHERN BORDER OF JUPITER'S EQUATORIAL CURRENT. *A. Stanley Williams.*—The equatorial surface current of Jupiter has so great a velocity that markings within it gain as much as five minutes in each rotation on those lying outside. This well-known fact is sometimes forgotten by observers, who try to identify equatorial spots by their position with regard to the Red Spot. It is remarkable that considerable variations have occurred in the boundaries of this current, especially in the northern. From 1887 to 1892 the boundary fell very close to the extreme S. edge of the N. equatorial belt, but in 1898, judging by the rotation-period of an interesting group of spots situated on its northern edge, the whole belt was included within the current. The group varied singularly little during three months, either in appearance or rate of motion, and it seems that only when the belt is on the edge of the current is it subject to such abnormal disturbances as were witnessed in 1896–7, and in 1899. When wholly without the equatorial current, as in 1887–92 or 1893, or wholly within it, as in 1898, it is comparatively quiescent. (**A.S.P.**, October 1899.)

THE ROTATION OF SATURN. *W. T. Lynn.*—The period of Saturn's rotation, as given by many modern astronomical books, is merely a question of an hour too long. The origin of the error is due to Baily, who gives in his "Tables" the quantity obtained by Sir W. Herschel for the rotation of the ring instead of that of the planet. It is extraordinary that the error appears in Sir John Herschel's treatise on Astronomy, and in all the successive editions of the "Outlines" founded on that treatise. (**Obs.**, December.)

The LEONIDS. *G. Johnstone Stoney, A. M. W. Downing.*—The writers referring to their previous paper, in which they had come to the conclusion that the most probable time for the middle of the shower would be November 15^d 18^h, say that a further investigation of the dynamical conditions which prevailed when the Leonids were drawn into our system by Uranus has shown that the stream is not thread-like but strap-shaped, and that in consequence of perturbations the part of the stream which the earth cut through in 1866 will now cut the plane of ecliptic at a point some 1,300,000 miles nearer the sun. It was thought likely that the breadth of the strap would be sufficient to ensure a great shower this year, but as the plane in which this breadth lies has been rotating in such a direction as to meet the earth, the shower would probably take place earlier than the epoch previously announced.

In a subsequent letter Dr. J. Stoney says that the fact that we have not had one of the great showers this year shows that the width along the section which was at the descending node on November 18 is not sufficient to reach the whole way to the earth's orbit. (**Nat.**, November 9, 23.)

THE LEONIDS.—*Mr. Denning* gives a summary of observations which have reached him. Prof. A. S. Herschel commenced watching on November 6, but saw no Leonids. Two possible Leonids were seen on November 8, and two others on Novem-

ber 10, the first certain Leonids were seen by Mr. Denning on November 11, and they appeared to indicate a stationary radiant at 152°, + 23°. Observations were much interrupted by clouds, but some were recorded on the 12th and 13th, the greatest number reported being 200 between 15^h and 18^h on November 14 by Mr. A. R. Schulz at Worthing. Further observations on the 15th, 16th, and 17th, indicate that the Leonids were not more numerous than in ordinary years when the comet is not far from aphelion. From the few telegrams to hand from Europe and America the display seems to have been meagre in widely different longitudes. Mr. Denning expects that exhibitions of the finest kind will be presented in 1900 and 1901, and it is to be hoped that one or other of these may be visible in England.

Reports from Greenwich show that during a break in the clouds 16 Leonids were observed in 42 minutes on the morning of November 16, but that no photographs could be obtained.

Great preparations were made at South Kensington Observatory, but no photographs could be obtained, and from reports made by observers at Hampstead, Banstead, and Brighton, it is clear that the earth did not pass through any very dense portion of the swarm. (**Nat.**, November 23.)

METEORS.—Observations of the Perseids are given by Prof. G. Lewitsky at Dorpat, Herr Wolf at Heidelberg, Father O. Slavik at Kalocsa (**A.N.**, No. 3604), and of the Leonids by Father Slavik at Kalocsa (**A.N.**, No. 3601), M. Loewy at Paris, M. Janssen at Meudon, M. Bigourdan at Paris, M. Baillaud at Toulouse, M. Deslandres at Meudon (**C.R.**, No. 21, 1899, November 20), and M. Guillaume at Lyons, M. Trépied at Algiers, and M. Harold Tarry, also at Algiers (**C.R.**, No. 22, 1899, November 27).

THE DUPLEX SPECTRUM OF NOVÆ.—Prof. F. Wilsing has written a most important paper which throws light on the very anomalous condition of the spectrum of a new star. Thus in Nova Aurigæ (1892) there were numerous double lines consisting of a bright line with an absorption line on its refractive side. P Cygni, the Nova of 1600, possesses a similar double spectrum. If we explain the double spectrum by a double star system the enormous relative velocities, unknown in the case of any optical binary, raise almost insuperable difficulties. But in the "Astro-Physical Journal," Vols. III.–VI. Profs. Humphreys and Mohler have shown that a small shift of the lines is shown in the arc-spectrum of metals as the pressure in the vessel containing the electrodes rises to 12 atmospheres; that the metallic lines shift with increasing pressure towards the refractive end of the spectrum; and that the shift varies with different metals, But whilst the change of wave-length of the metallic line for a pressure of 12 atmospheres scarcely amounts to $0{\cdot}005\mu\mu$. the shift of the hydrogen lines $H\gamma$ and $H\delta$ in Herr Vogel's measures reaches $+ 0{\cdot}85\mu\mu$ and $+ 0{\cdot}44\mu\mu$ respectively, and these lines have breadths of $2{\cdot}28\mu\mu$ and $1{\cdot}49\mu\mu$. Then Prof. Wilsing found that there were shown very considerable changes and widenings of the spectra when an electric spark was passed between metallic electrodes immersed in fluid, whereby the

metallic vapours are under much greater pressure by several hundred atmospheres than in the experiments of Humphreys and Mohler; whilst the shift was in all cases in the direction of increasing wave-lengths, the amounts were much greater in the easily friable metals cadmium, zinc, copper, than in nickel, iron, or platinum.

In spite of the resemblance of appearance of these spectra to those in the stars, there is still a big gap to be filled up. Ordinarily the hydrogen lines, broad with increasing pressure, lose their sharpness, so that accurate measures cannot be taken. But researches on the hydrogen spectrum in a Gleissler tube have shown that this broadening does not enter when the temperature of the discharge remains sufficiently low, and in this case an accurate connexion between the shift and the increase of pressure can be found. From these experiments Prof. Wilsing is inclined to explain the phenomenon of new stars as a disturbance of the equilibrium of a star already, perhaps, far advanced in its development, a disturbance, perhaps, brought about by the gravitating influence of another star.

A single star can, however, also give a double spectrum when its kernel is surrounded by an expansive and intensely brilliant atmosphere. This may be the cause both of the variability and the duplex spectrum of both γ Cassiopeiæ and P Cygni.

Prof. Wilsing then gives a formula by which the pressure of the stellar atmosphere may be found, where the shifts of several lines are known. (A.N., No. 3603.)

In the same number of the "Astronomische Nachrichten," Prof. A. Belopolsky gives a series of measures of lines in P Cygni.

THE POSITION OF STARS OF TYPE IV. AND VARIABLE STARS OF TYPE III. IN REFERENCE TO THE MILKY WAY. *T. E. Espin.* —Dunér has shown that stars of Type IV. have a tendency to collect in the Milky Way. Probably all of the fourth type stars are now known down to the 8·5 mag.; their distribution, obtained by counting the numbers in each zone of 10° of galactic latitude, fully confirms Dunér's statement, and shows that 55 per cent. are found within galactic lat. 10°, and 74 per cent. within galactic lat. 20°. In longitude they are nearly uniformly distributed.

The variable stars of Type III., treated in the same way show a tendency to collect on the borders of the Milky Way in galactic latitude 20° to 30°; there is also a distinct tendency to grouping, such groups occurring in Delphinus, Cygnus, Canis Minor, Libra, and Sagittarius. (Ap. J., 1899, Oct.)

THE VARIABLE VELOCITY OF POLARIS. *W. W. Campbell.*—Numerous spectra of the pole star obtained with the Mill's Spectograph in August 1899 give velocities in the line of sight varying from — 8·6 km. to — 15·2 km.

The results when plotted show that Polaris is a spectroscopic binary, having a period of a little less than four days. Previous measures of the spectrum made in 1896 showed, however, a nearly constant velocity of — 19·6 km., but the observations were made at intervals, differing but little from multiples of the period, and the variation was, therefore, not revealed.

It is evident, however, that the 1896 observations lie entirely outside the present range of values, from which it is inferred that the velocity of the binary system is changing under the influence of a third body. (Ap. J., 1899, Oct. *See also* A.S.P., 1899, Oct.)

THE VARIABLE VELOCITY OF POLARIS. *E. B. Frost.*—Measures were made on three plates obtained by Mr. Ellerman during August and September 1899, and the results fully confirm Prof. Campbell's important discovery. The velocities range from − 10·6 km. to − 17·7 km. with a probable error of about ± ·5 km. (Ap. J., 1899, Oct.)

HEAT RADIATION OF THE STARS. *George E. Hale.*—From Yerkes Bulletin, No. 11, we learn that Dr. E. F. Nicholls, Professor of Physics in Dartmouth College, was invited to attempt to detect stellar radiations with a remarkably sensitive form of radiometer of his own construction. Two mica disks, 2 mm. in diameter, supported by a light cross arm on either side of a thin glass staff, and hung by an exceedingly fine quartz fibre in a partial vacuum, were exposed in the focus of a 24-inch mirror of 8 feet focal length. After two reflections at plane surfaces the rays entered the micrometer through a fluorite window. The radiometer is about five times as sensitive as Professor Boys', and the area of the concave mirror 2·4 times as large, but there is one additional reflection. Neglecting atmospheric absorption, and assuming total reflection by the mirrors, a candle 15 miles away should give a deflection of 0·1 mm. Seven determinations for Arcturus, each the result of from 21 to 47 deflections, gave a mean of 0·60 mm. Seven determinations on Vega gave 0·27 mm. The smallness of the deflections and the rapid atmospheric fluctuations render the quantitative results somewhat uncertain; but it is concluded that we do not receive from Arcturus more heat than we should from a candle at a distance of five or six miles, no account being taken in the latter case of atmospheric absorption. (P.A., Nov.)

VARIABLE VELOCITIES OF STARS IN THE LINE OF SIGHT. *H. F. Newall.*—Prof. Campbell has recently published an additional list of stars whose spectra indicate variation in radial velocity; and in the case of one of these, Capella, his results are confirmed by the writer's own observations, made with the spectroscope attached to the 25-in. equatorial of the Cambridge Observatory, by which the binary nature of this star was discovered. Prof. Campbell considers that Polaris is a binary system whose velocity is changing under the influence of an additional disturbing force, that it is, in fact, at least a triple system. This, however, is a conclusion that is hardly justified by the evidence given. (Obs., December.)

VARIABLE STARS IN THE CLUSTER MESSIER 5.—In a paper read before the Conference of Astronomers at Yerkes Observatory, Prof. Bailey stated that the variable stars in M. 5 have all nearly the same period, about half a day, and nearly the same magnitude, ranging from 14^m to 15^m. No relation exists between the distance of the star from the centre of the cluster and its period. (A.S.P., October 1899.)

SPIRAL NEBULÆ.—Prof. Keeler points out that the spiral form of nebulæ seems to be the rule rather than the exception, if we leave out of the question such extended diffuse nebulæ as the one in Orion or the Trifid, or the great nebulous clouds scattered through the Milky Way. In many cases of compact isolated nebulæ, such as Messier 32, which is a round cometary mass, and is very bright in the middle, fading gradually outwards, specially good conditions of atmosphere or exposure may show structure where now it appears structureless. Such forms may, however, be simply the result of the aggregate moment of rotation from motion inherent in the particles of the original contracting mass. The number of new nebulæ found by the photographs with the Crossley reflector is simply enormous. (A.N., No. 3601.)

Variable Stars.

Minima of the Variable Stars of the Algol Type.
(Given to the nearest hour G.M.T.)
(P.A., 492.)

U Cephei.	*Algol.*	*S Cancri.*	*S Velorum.*
d h	d h	d h	d h
Dec. 3 11	Dec. 3 19	Dec. 1 9	Dec. 2 12
" 5 23	" 6 15	" 10 21	" 8 10
" 8 11	" 9 12	" 20 9	" 14 9
" 10 23	" 12 9	" 29 20	" 20 7
" 13 11	" 15 6		" 26 6
" 15 22	" 23 20		
" 18 10	" 26 17	*U Coronæ.*	
" 20 22	" 29 14	d h	
" 23 10	" 32 11	Dec. 1 16	*DM* + 45°·3062.
" 25 22		" 8 14	
" 28 10		" 25 20	d h
" 30 21			Dec. 3 19
		R Canis Majoris.	" 8 9
	λ Tauri.	Every 8th Min.	" 12 23
	d h	$P = 1^d\ 3^h{\cdot}3$	" 17 13
	Dec. 3 8	d h	" 22 2
W Delphini.	" 7 7	Dec. 6 17	" 26 16
d h	" 11 6	" 15 19	" 31 6
Dec. 22 7	" 15 5	" 24 21	

Additions to the Library.

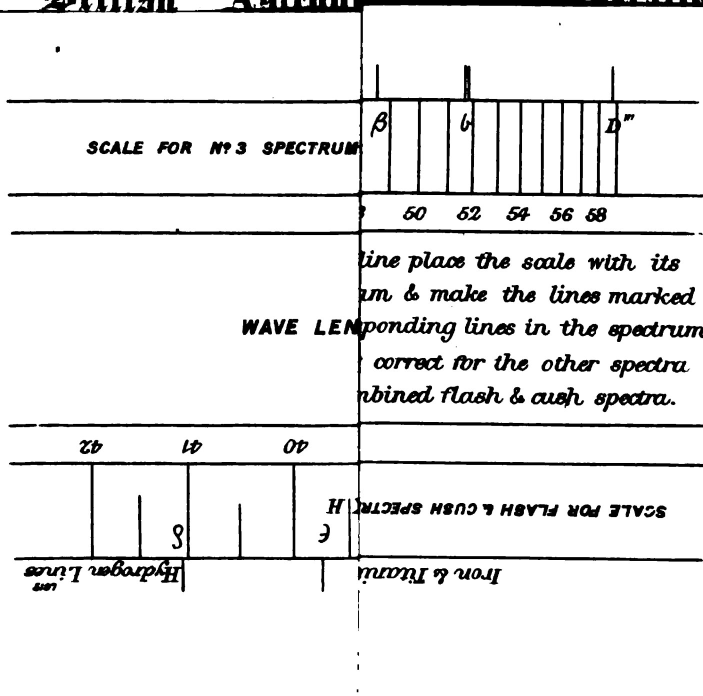
Young.—The Sun (new edition).
Cortie.—The November Meteors.
Himmel und Erde.—Vol. XI.
Philadelphia.—American Philosophical Society.—Proceedings, Vols. XXXVI., XXXVII.
Madras Observatory.—Report, 1898–99.
The Earth Measured.
Southport: Society of Natural Science, Reports I.–III.
Rambaut.—Orbit of the part of the Leonid Stream encountered by the Earth, 1898, November 15.

Published December 19, 1899.

The Journal

of the

British Astron



Mr. Maunder read this address, and said he sincerely trusted Col. Markwick's appeal for names would be very fully responded to. He was perfectly sure Col. Markwick would do everything in his power to make the Section a success, and especially to help beginners in the work of variable star observations. He therefore hoped that not only all the old Members of the Section would send in their names at once; but also there would be a large number of new observers who would enter on this work, and seek Col. Markwick's aid, and give him their support.

The *President* remarked that Col. Markwick had inaugurated his Directorship by an exceedingly practical address, and he could only repeat what Mr. Maunder had said, namely, that he hoped this would mark the beginning of great activity in the

Variable Star Section. He was quite sure Col. Markwick would not wish for any better return for his trouble than ample support in his work.

Mr. Petrie read a paper by Mr. Stanley Williams entitled "Considerations on the Double Canals of Mars."

Some notes by M. Antoniadi on this paper were also read.

Father Cortie said he was not a Martian observer, but there was one point in Mr. Stanley Williams's paper that struck him, namely, the analogy the writer drew between observing the canals of Mars and double stars. He (the speaker) did not think the argument held, because in observing double stars they were observing two distinct bright points upon a black sky. In observing the canals of Mars they were observing on a background which, of itself, was a very difficult object to see, and was continually changing in definition. They could not very well compare photographs of stars with those of planets. The former were perfectly clear, but no one had yet been able to obtain a good photograph of a planet. Even Prof. Pickering's photographs of planets—Saturn and Jupiter for instance—were very blurred. Therefore, he did not think that this particular argument for the objective reality of the doublings of the canals of Mars held. With regard to the doubling of canals he had no theory on the point; but, from experience in observing the spectrum, he could say that when the eye became tired the lines began to double. It then became necessary to alter the focus, and after a short rest the lines were seen to be single. Perhaps this had something to do with the doubling of the canals on Mars; he did not know—he only threw out the suggestion.

Mr. A. J. S. Adams said that the eye could often be focussed so as to double a line, but it so happened that one line was always darker than the other. He wished to know whether the Martian doubles were equally dark, or whether one was slightly lighter than the other.

Capt. Noble said it was noteworthy that the most wonderful things ever beheld on Mars had been seen, perceived, or imagined—whatever they chose to call it—when the planet was a long way from the earth, and unfavourably situated. During the opposition of 1877—that most favourable opposition, when those superb drawings which would be always classic were made by the late lamented President of the Association, Mr. Green, at Madeira—none of these marvels were visible; but when they had the planet a very long way off the sun and earth, and perhaps showing gibbosity, in fact, in a generally unfavourable position for observation, it was surprising what could be seen upon it.

Mr. Holmes remarked upon what Capt. Noble had said about the markings on Mars being more visible when long past opposition. He himself had made some remarks upon the point before; but upon reflecting on what happened in case of the moon, he could not help seeing that there might be something that might cause the markings to be more visible at quadrature

than when in opposition. For instance, dark markings on the moon were very much more easily seen at other times than full; when the moon was full they did not see them. When it was some distance from full the markings were very much more perceptible. He did not see why something of the kind might not be quite analogous to that in the case of Mars; but at the same time he had not the slightest faith in the duplicity of the canals. As to the point Mr. Stanley Williams raised about double stars, no one could have looked at them very much without knowing they very often did double. He had spent some time observing particular cases, and had been quite unable to tell whether he saw two stars or four. That was largely owing to the state of the atmosphere, and what would double a star in that way would also double other objects. Mr. Williams seemed to raise a distinction between a double canal and two single canals side by side. He (Mr. Holmes) did not quite follow the distinction. Two single canals side by side would be apparently much the same thing as a double canal.

Mr. Newbegin desired to be allowed to corroborate a remark made by Father Cortie, who mentioned having seen one of the lines of the spectrum doubled. He himself had seen the C line doubled, and he did not know whether it had been through the fault of the eye or the fault of the light. Mr. Thwaites had seen the same thing. Until that gentleman drew his attention to it, he had never seen such doubling, but since that time he had on one or two occasions seen the C line in the spectrum of the sun doubled.

Mr Saunder said he had made some experiments on the duplication of the lines of a micrometer as seen in the telescope. The webs of the micrometer could very easily be seen double by putting the eye-piece a little out of focus. He discovered in that way what he had a suspicion of before—namely, that he had a slight amount of astigmatism in his eye. It was such as to require a cylindrical lens of 50-in. focus to correct it; but this was enough to cause the lines in one direction to go out of focus very much before those at right angles to them, showing that a slight error of focus would effect a sensible duplication. He did not quite follow what Mr. Holmes said about the dark markings on the moon disappearing at the time of full. What markings disappeared?

Mr. Holmes: The shadows.

Mr. Saunder: The shadows disappear because they are not there when the sun is high.

Mr. Holmes: Would not the same thing follow in the case of Mars?

Mr. Saunder: That is, supposing the canals are shadows.

Mr. Holmes did not suggest that, but merely thought, as we do not know what the nature of the markings is, they should not condemn their existence because of non-visibility at times of opposition as compared with other times.

Mr. Crommelin could corroborate what Mr. Saunder said about it not being difficult to make a spider line in the telescope appear double when out of focus. He noted it independently long before M. Antoniadi suggested this interpretation of the duplication of the canals. He also noticed, as Mr. Saunder said, that the ease with which they could duplicate the line depended on its inclination to the vertical. Of course, that was a question of the astigmatism of one's eye. With him a horizontal line was much easier to duplicate than a vertical. He did not think M. Antoniadi was quite fair in taking Mr. Phillips's observation, when Mr. Phillips saw the canal doubled for a few seconds, for, as Mr. Phillips said, it was obviously only the effect of atmospheric unsteadiness. Mr. Stanley Williams was talking of canals that appeared double during the whole evening; so that it was scarcely fair to compare the two things. Mr. Stanley Williams' point was a strong one about the two canals from the two portions of "Dawes' Forked Bay." No one had ever questioned the real duplicity of that bay, and the two canals that went from the two heads of the bay would certainly seem to be real. It was only some canals Mr. Williams was contending for. There were some instances which he would allow to be caused by optical illusion. If they could get any real instances of duplication it would be an interesting result, and this he (Mr. Crommelin) thought Mr. Williams had established as regards the instance mentioned and a few other canals.

Mr. Fletcher said that, in the case of astigmatism, part was muscular and part structural. That which was structural was permanent; that which was muscular was variable. This would explain why a line might appear single one moment and double the next. He desired to know whether those canals which were at right angles to the sun's rays at any particular time were more distinct than others so placed that at the same time the sun's rays shone along rather then across them, which should be the case if the canals were due to shadows caused by inequalities of level.

The *President* said they were very much indebted to Mr. Stanley Williams for his very interesting paper, and also to M. Antoniadi for his note upon it, which had aided the discussion very much. He (the President) could quite confirm what Mr. Holmes had said, that there were many cases in which it was very difficult to see whether a star was single or double, or whether a double star was four stars, as Mr. Holmes put it. The duplication of the micrometer wires also was a very common phenomenon. Anyone who had done much double star measuring must have had hundreds of experiences of that kind. It was also noticeable that occasionally, when you had been at work some hours, you would get a duplication without a change of focus; that was, that the focus that suited the eye when you started work did not suit it after a long spell of work on a particular pair of stars. You would then naturally re-focus; but before doing that, you certainly did get duplication of the webs. He personally had never noticed any difference in the duplications of horizontal and vertical wires. That was purely a personal matter, but it

would be found sometimes, in using high powers, that the very small difference of focus required for the nearer of the movable webs, as compared with that for the more distant web, was quite sufficient to give duplication of one and not of the other. Of course, with moderate powers that was not noticed, but with high powers, the very small difference in the planes of the two webs was quite sufficient to determine the duplication of either the near or far web, as the case might be.

The *President* called upon Mr. Maunder to make an announcement respecting the arrangements made for the eclipse expedition of next year.

Mr. Maunder emphasised that these arrangements would necessarily fall through unless a sufficient number of passages had been definitely engaged on or before January 31, immediately after which date they must close their contract with the Royal Mail Steamship Company. If they carried out the proposed arrangements, he thought they would be able to organise a very successful and very cheap expedition to observe the eclipse.

Father Cortie presented the Eighth Report of the Solar Section, which dealt in detail with the sun-spots observed during the year 1898.

Slides to illustrate the Great Spot of September 1898, of drawings made by Mr. Astbury, and at Stonyhurst, were thrown upon the screen.

Father Cortie said that now that we had almost reached the time of the minimum of solar spots, observers of the sun might very profitably turn their attention to observing the solar surface and the wonderful changes that took place upon it, even at times of minimum. It was only rarely that the granulated structure could be seen, when the conditions for observing were exceptionally good. Generally the sun's surface appeared to be mottled, but when the seeing was above the average, the bright mottling was broken up into distant grains as if handfuls of rice had been scattered over the surface. In the spectroscope on such occasions he had seen the spectrum crossed lengthways by a succession of light and dark lines, as if the dark spaces of the réseau were miniature spots. Then, again, there was the subject of "veiled spots," which, so far as he was aware, had only been studied by Trouvelot, and at Stonyhurst. These "veiled spots" differed from the "penumbral markings," which sometimes persisted for several days in the neighbourhood of a spot group, and were either the first beginnings or the remains of a spot group before it became merged in the photosphere. The "veiled spots" were continually changing.

A series of slides was thrown upon the screen from the Stonyhurst drawings, illustrating the "veiled spots," and showing their rapid developments. The genesis of the "blurred patches" in M. Janssen's photographs of the solar surface was most probably due to the change of "veiled spots" from the form in which they first appeared, round and perfectly distinct, until they became diffused, and extended over a larger area. These changes

took place in a very few minutes. One slide exhibited the change as taking place in four minutes. The "veiled spots" were best seen in the early morning, before the telescope had become heated. A series of M. Janssen's photographs was then shown, to illustrate the granulated structure of the solar surface, the dark network or réseau, and the blurred patches.

In conclusion, he would wish to call the attention of observers of the Solar Section to the remarks made by the President in his inaugural address for the present Session as to the drawing up of observations. Frequently drawings were sent on half-sheets of notepaper, and the drawings were mixed up with descriptive matter. He would suggest that all drawings should be made upon a separate sheet of drawing paper of the size of the "Journal," and should bear upon them the date and time of observation, the observer's name, and the scale—so many inches or millimètres to the solar diameter. Enlarged drawings were preferable to those on a small scale. The descriptions, notes, and measurement of positions should be on paper of ordinary foolscap size, unless observers had printed forms for this purpose.

Mr. Maunder showed a number of slides from negatives taken at the Royal Observatory, Greenwich, illustrating the life-history of the great group of spots of September 1898, during its second and third apparitions, viz., those beginning September 3 and September 30. Mr. Maunder wished to take the opportunity afforded by the presentation of the admirable report Father Cortie had made on the work of the Solar Section, to point out a rather curious circumstance with regard to the solar spots of 1897 and 1898. Directing attention to a diagram, Mr. Maunder said that in 1874 the mean spotted area was about 1,400 millionths, or one in 700 of the surface of the visible hemisphere of the sun. In the following years it declined rapidly, and in 1878 it had come nearly to zero. From 1879 it increased very rapidly indeed until 1883, each successive year showing a spotted area very greatly in excess of the preceding one. Then from 1883 it came down somewhat more gradually until they got to the next minimum in 1888, 1889, and 1890. Then there was a straight run up to the time of maximum in 1893. From 1893 to 1896 there was just as rapid a decline, but in 1897 there was a check; and the mean area for 1897 was practically the same as for 1896; but in 1898 the fall was resumed, and in 1899 the areas still continued to rapidly decrease. But in 1897, when there was this curious check in the diminution of the sun-spot area, there was at the same time a curious alteration in the locality in which the spots were seen. In 1874, when the record commenced, the spots were mostly in latitude 10°. Then they approached the Equator somewhat, until just before the time of minimum, they found the spots in latitude 7°. Then at the actual minimum, and just before the rise towards maximum began, there was an immense change in the latitude of the spots, and their mean position was in latitude 22°. From that time forward the mean latitude of the spots began to shift towards the Equator until, at the time they had most spots, they found the mean latitude was about 14°, and the latitude went on decreasing again until, just a little before

they reached the spot minimum of 1889, they obtained the minimum of latitude at about 7°. The same process was repeated in this present cycle. There was a rapid run up to 21° latitude at the time of minimum in 1889, and before the increase in area began, followed by a steady movement towards the Equator as maximum was approached, and the mean latitude at the maximum of 1893, like that of the maximum of 1883, was about 14°. For three years there was very little change in the latitude; then in 1897, whilst the spotted area was abnormally maintaining its extent instead of diminishing, there was a most astonishing change in the latitude—a drop, in fact, to 8°, as if the minimum were already reached. This seems to have been due to the occurrence of several great groups in very low latitudes, close to the Equator, which was not at all usual at that period of the sun-spot cycle. In 1898, however, there seemed to have been a return very nearly to the normal state of things, both as to the mean area of the spots and their latitude, and it reproduced in both particulars very nearly the state of things observed in 1886, so that if the present cycle went on according to the precedent shown in the last cycle, they might expect the dead minimum of the present sun-spot cycle would follow about the middle of 1901.

Mr. Newbegin said the groups shown took him back to old times, for he had the pleasure of bringing some of them to the Association, and it was a great gratification to look over them again. The granulation of the sun shown by M. Janssen's photographs was of a most striking character, being only seen at intervals during a long period of observation. There was one question he wished to ask, more particularly for the sake of finding out whether he had been misled or taken in, or whether other observers had seen the same thing. He had on two or three occasions detected in the penumbra of a sunspot what he might call a "weatherhead" effect—prismatic colours forming a section of a circle something like the little rainbows seen when bad weather was about, commonly called weatherheads. On two or three occasions he had seen this effect. The colours seem to belong to the sun, because they moved with the spot as it moved in the polariser. He wished to know if anyone else had seen the same phenomena.

Mr. Thwaites said he had never really observed prismatic colours as mentioned by Mr. Newbegin. He had not used a polarising eye-piece, except occasionally with a friend's telescope. The solar eye-piece he generally observed with was formed of two prisms of slight angle, which reflected the image from their outer surfaces and did not give colour. Occasionally he had seen colour on the sun, but he had satisfied himself it had been due to want of focus. He had seen what some had called the "rice grains," but on very rare occasions—perhaps once or twice in a year, at the times of very best definition, and then only for a very short time. He had also noticed the areas of confusion—bad focus, as it were, of portions of the disk—which had been referred to, and was much struck with their appearance. They presented a marked

difference to the other portions of the field, which were sharply defined.

Mr. Evershed asked Father Cortie if he had studied the solar surface with monochromatic light. He himself had recently taken many photographs with monochromatic "K" light. He could not say for certain whether he had got veiled spots, but he had obtained very curious markings, evidently very much larger than the veiled spots. Occasionally he got a perfectly straight dusky marking, apparently radiating from a disturbed region.

Mr. Adams asked how much of the peculiar solar grain on Father Cortie's photographs were due to solar granulation, and how much to the ground glass. He did not recognise the usual appearance of the solar surface in these photographs.

The President inquired whether Father Cortie had seen any colour in the sunspots. On one occasion only had he himself seen colour, and that was just as a bridge was forming, and that piece of the bridge extending about one-third of the way across the nucleus was a very bright red. He tried a Dawes eye-piece, a first surface reflecting prism, and a polarising eye-piece, and the colour was the same in all of them. It was a very remarkable experience. Another question he wished to ask Father Cortie was: "What form of eye-piece he, on the whole, recommended "for direct visual observation of the sun?" Personally, he had rather a partiality for the Dawes eye-piece, but Father Cortie had had very large experience, and members present would doubtless be glad to have his views upon the matter.

Father Cortie, in reply, said he had not had much experience in observing directly—it was mostly by projection that he had observed. The eye-piece he had used, and found to be excellent as long as it lasted, was one made by Mr. Hilger, and described by him in the "Monthly Notices," Royal Astronomical Society, some years ago—a prism partially of glass and partially of Canada balsam; but he found it difficult to keep the latter without air-bubbles getting in; otherwise it gave magnificent definition upon the solar surface. He was now thinking of getting a polarising eye-piece constructed, because many observers seemed to prefer that form. With regard to the other question of the President, the red veils in spots were frequently seen at times of maximum by projection on the drawing-board. Once at Stonyhurst they had seen a yellow veil corresponding to the wave-length of D^3. With reference to the other colours Mr. Newbegin and Mr. Thwaites referred to, he had never seen those unless, indeed, they were caused by the chromatism of the telescope used. Employing a very high power for projection upon a drawing-board, they would see a coloured fringe round the spots, due to the chromatism of the object-glass, and not to anything on the surface of the sun. In reference to Mr. Adams's question, he reminded that gentleman that the illustrations were not photographs, but drawings on ground glass.

The *President* said he happened to have a special solar eye-piece which was made by the late Mr. Thomas Cooke for the

late Rev. W. R. Dawes, some 30 years ago. He found this a particularly useful eye-piece, if it was desired to take micrometric observations of the sun. It consisted of an ordinary first surface reflecting prism, the rays from which fell on a second first surface reflecting prism, so that the light was reduced enormously; not only so, but the image was exactly the same as if seen through the telescope direct. The definition did not appear to be at all marred by the double reflection. Between the two prisms was a coloured graduated wedge which could be used to further reduce the light. So far as he knew, it was the only such eye-piece ever made. Mr. Dawes read a paper upon it before the Royal Astronomical Society in the late "sixties" or early "seventies," but speaking from memory he could not give the exact date.*

Mr. Mark Wicks said he watched the progress of the large group of spots across the sun's disk in September 1898, and had splendid seeing by the aid of a specially designed apparatus attached to his 4-in. Gregorian, which he described. The amount of detail seen was such that the photographs of the same group of spots taken at Greenwich, which had been thrown upon the screen, seemed to him very disappointing, as he assumed that a much larger instrument than his was used there.

Mr. Goodacre, the Director of the Lunar Section, presented a preliminary report regarding the recent lunar eclipse.

Mr. J. Milton Offord exhibited a series of 12 lantern slides from photographs of the recent lunar eclipse, showing the progress of the earth's shadow at intervals of a quarter of an hour. The telescope employed was a 12½-in. reflector, the lunar image being enlarged to over two inches diameter by a negative lens. At the time of greatest obscuration, the small portion of the moon remaining was readily photographed. In addition to the series on an enlarged scale, Mr. Offord also showed two photographs taken near the time of central eclipse, to which exposures amounting to 600 times the normal for the full moon had been given; these negatives exhibit most of the seas on the eclipsed portion of the disk, nearly the whole of the moon being visible, the light gradually fading away as the deeper parts of the shadow were reached. When these photographs were taken the limb of the moon appeared lighter than the centre to the naked eye, an optical illusion arising from the darkness of the surrounding sky.

The Meeting adjourned at 7 p.m.

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* The Rev. W. R. Dawes' paper was read before the Royal Astronomical Society in 1865, and will be found in the "Monthly Notices," Vol. XXV., p. 218.—W.H.M.

Reports of the Branches.

WEST OF SCOTLAND (GLASGOW).

The third Meeting of the Sixth Session of this Branch was held on Friday evening, 15th December. A letter of apology for unavoidable absence being received from the President, Rev. Edward Bruce Kirk, Mr. John Dansken, F.R.A.S., Vice-President occupied the chair. The election of five new Members (a sixth being held in suspension till next Meeting) was declared; and two new Members and eight Associate Members were nominated for election. An extract from the American Journal "Popular Astronomy," dealing with the subject of life in other worlds, was read by Mr. John Main, F.G.S., the Secretary. Notes on the constellations in the southern meridian during December were also given, including Eridanus, Orion, Taurus, and Perseus: special references being made to the nebula in Orion, nebulæ in the Pleiades, the Crab nebula in Taurus, the clusters in Perseus (Messier, 34, and Herschel, 33 and 34), and the noted variable, Algol, in Perseus; illustrated by a series of lantern views of their constellations. Major Cassells then exhibited a number of slides from London, taken from recent photographs of the planets, illustrating the phases of Venus, double canals on Mars, polar cap of Mars, cloud belts of Jupiter, ring system of Saturn (at present well open for observation), and the supposed cloud belts of Uranus, resembling the Jovian belts, but fainter, of course. These views were briefly explained while shown on the screen, by Mr. Main, the Secretary. They were very interesting and instructive, and formed a very entertaining feature in the evening's programme, being accurate pictures of the planets taken from recent photographs of the planets as stated. Mr. Main also read several reports received from the parent Association, dealing with the recent meteoric showers. These reports contained a synopsis of the observations made at various places, stating the number of meteors seen, and the weather conditions experienced at time of observation. Mr. Henry MacEwen, F.R.A.S., Director of the Mercury and Venus Section of the British Astronomical Association, submitted a very full report of the work done by Members of the Section on these planets. Mr. MacEwen referred to the great difficulty connected with proper observation of these two planets, owing, mainly, to the proximity of Mercury to the sun, and the intense brilliancy of Venus; there facts were important factors in increasing any existing difficulties experienced in studying the characteristic features presented to our view. The difficulty of dealing with Mercury, as Mr. MacEwen pointed out, was chiefly one of position; that of Venus, owing to it proving such a trying object to the observer's eye and in instruments of all apertures. Referring to the most suitable time for viewing Venus, Mr. MacEwen said, that from the experience of himself and others, there seemed to be a concensus of opinion that Venus

is best observed at western elongation, about the time of sunrise; the intense glare of the planet being modified, and so allowing details to be seen, which at other times are lost in the glare of light. The report dealt at some length with the much discussed question of the rotation of Venus, and the diversity of opinion among modern observers regarding the question of whether Venus had a day practically the same as the earth's, or whether the axial and orbital revolutions coincided. Some of the opinions had, as Mr. MacEwen said, been founded on observations taken without sufficient lapse of time, and consequently without proper data on which to found conclusions regarding rotation period. He pointed out that before deductions of any probable value could be made, the observations must be taken at intervals of, perhaps, a month or so, and not after a few hours only, for purposes of comparison, due allowance being made (as in the case of Jupiter's satellites) for increase of distance, which naturally must affect the apparent motion of any markings observed.

The question brought about some good discussion, to which Mr. MacEwen replied at some length. On the motion of the chairman a cordial vote of thanks was awarded to Mr. MacEwen.

EAST OF SCOTLAND (EDINBURGH).

The third Meeting of this Branch for the current Session was held at No. 5, St. Andrew Square, Edinburgh, on Saturday, 16th December, the President in the chair.

Mr. W. Forgan gave a lecture on "Astronomers and their Telescopes," illustrated by limelight views. A large number of slides was shown, many being interesting portraits of early astronomers, and many curious out-of-the-way points and incidents in their histories were related by the lecturer.

In the second portion of his address, Mr. Forgan gave many particulars regarding historical and famous telescopes, illustrating his remarks by views of a large number of instruments. Amongst the most interesting may be mentioned views of Newton's first reflector, Herschel's famous instruments, and Lassell's and Nasymth's ingenious telescopes. Views of large modern instruments and observatories were also shown, and Mr. Forgan incidentally described methods of grinding mirrors adopted by telescope makers, pointing out wherein the grinding machine failed to produce a perfect speculum.

At the close of the lecture a number of Dr. Max Wolf's admirable photographs of star fields were thrown upon the screen.

Mr. Forgan's address was followed with much pleasure and interest, and a hearty vote of thanks was accorded to him. A short discussion followed.

One new Member and five Associates of the Branch were elected.

Reports of the Directors of the Observing Sections.

Lunar Section.

THE POSITION OF THE LUNAR TERMINATOR.

Some years ago the late Mr. Herbert Sadler favoured the Director with particulars of two tables and rules for the application of the same by which the position of the lunar terminator could be obtained on any given day and hour in any year from 1780 to 1899 inclusive. These particulars appeared also in the "Selenographical Journal," and have since then been reproduced in Elger's "Moon," and other publications.

Their value in the past having often been proved, I have, at the request of several lunar observers, made the necessary computations for extending Table I. from 1900 to 1999, the formula used having been kindly supplied by Mr. A. C. D. Crommelin, F.R.A.S.

TABLE I.

POSITION OF THE MOON'S TERMINATOR ON MARCH 1 NOON, G.M.T., OF EACH YEAR.

Year.	—		Year.	—		Year.	—		Year.	—	
	°	′		°	′		°	′		°	′
1900	89	27	1925	15	42	1950	301	57	1975	228	13
1901	319	48	1926	246	4	1951	172	19	1976	86	25
1902	190	11	1927	116	27	1952	30	31	1977	316	47
1903	60	33	1938	334	38	1953	260	54	1978	187	10
1904	278	45	1929	205	1	1954	131	16	1979	57	32
1905	149	7	1930	75	23	1955	1	39	1980	275	45
1906	19	30	1931	305	45	1956	219	50	1981	146	6
1907	249	53	1932	163	57	1957	90	13	1982	16	28
1908	108	5	1933	34	19	1958	320	35	1983	246	50
1909	338	27	1934	264	41	1959	190	56	1984	105	3
1910	208	50	1935	135	3	1960	49	9	1985	335	25
1911	79	12	1936	353	15	1961	279	32	1986	205	47
1912	297	24	1937	223	38	1962	149	54	1987	76	9
1913	167	46	1938	94	0	1963	20	17	1988	294	22
1914	38	8	1939	324	23	1964	238	28	1989	164	44
1915	268	30	1940	182	35	1965	108	51	1990	35	7
1916	126	43	1941	52	57	1966	339	13	1991	265	28
1917	357	5	1942	283	19	1967	209	35	1992	123	41
1918	227	28	1943	153	42	1968	67	47	1993	354	3
1919	97	50	1944	11	54	1969	208	9	1994	224	26
1920	316	1	1945	242	17	1970	168	31	1995	94	48
1921	186	23	1946	112	38	1971	38	54	1996	312	59
1922	56	45	1947	343	0	1972	257	5	1997	183	21
1923	287	7	1948	201	13	1973	127	28	1998	53	42
1924	145	19	1949	71	35	1974	357	50	1999	284	4

Table II.

Position of Moon's Terminator at Midnight G.M.T. for each day of year:—

Days.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	January.	February.
	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′
1	6 5	23 44	29 42	48 18	54 57	73 50	92 28	98 28	116 9	121 10	138 5	155 0
2	18 16	35 55	41 55	60 32	67 10	86 3	104 40	110 39	128 18	133 20	150 15	167 10
3	30 26	48 7	54 7	72 45	79 23	98 16	116 53	122 51	140 29	145 30	162 25	179 20
4	42 37	60 19	66 19	84 58	91 38	110 29	129 5	135 2	152 39	157 39	174 34	191 29
5	54 47	72 30	78 32	97 12	103 51	122 42	141 17	147 14	164 50	169 49	186 43	203 40
6	66 58	84 42	90 44	109 24	116 5	134 55	153 30	159 25	177 0	181 58	198 52	215 49
7	79 9	96 53	102 57	121 38	128 18	147 8	165 42	171 36	189 10	194 8	211 2	227 59
8	91 19	109 5	115 10	133 50	140 31	159 21	177 55	183 48	201 21	206 18	223 12	240 8
9	103 30	121 16	127 22	146 4	152 45	171 34	190 6	195 59	213 31	218 27	235 21	252 19
10	115 40	133 28	139 35	158 18	164 58	183 48	202 19	208 10	225 42	230 37	247 31	264 29
11	127 51	145 39	151 47	170 31	177 12	196 0	214 31	220 21	237 51	242 46	259 39	276 38
12	140 3	157 51	163 59	182 44	189 24	208 13	226 43	232 33	250 2	254 56	271 49	288 49
13	152 13	170 4	176 13	194 58	201 38	220 26	238 55	244 43	262 11	267 6	283 58	300 58
14	164 24	182 15	188 26	207 11	213 52	232 39	251 7	256 55	274 22	279 15	296 8	313 9
15	176 34	194 27	200 38	219 24	226 4	244 51	263 20	269 7	286 33	291 25	308 17	325 19
16	188 46	206 39	212 51	231 38	238 18	257 4	275 31	281 17	298 42	303 34	320 27	337 29
17	200 57	218 50	225 4	243 51	250 31	269 17	287 44	293 28	310 53	315 44	332 37	349 38
18	213 7	231 4	237 17	256 5	262 45	281 29	299 55	305 39	323 2	327 53	344 46	1 49
19	225 18	243 15	249 30	268 17	274 57	293 44	312 7	317 50	335 12	340 2	356 56	13 59
20	237 29	255 28	261 42	280 30	287 11	305 56	324 19	330 1	347 22	352 11	9 5	26 10
21	249 40	267 39	273 56	292 44	299 24	318 9	336 31	342 12	359 32	4 21	21 15	38 21
22	261 51	279 52	286 8	304 59	311 37	330 21	348 43	354 22	11 41	16 31	33 24	50 30
23	274 3	292 4	298 21	317 10	323 51	342 34	0 54	6 33	23 52	28 40	45 34	62 41
24	286 13	304 16	310 34	329 24	336 4	354 46	13 7	18 44	36 1	40 50	57 43	74 51
25	298 25	316 28	322 47	341 38	348 17	6 59	25 18	30 55	48 11	52 59	69 53	87 1
26	310 36	328 41	335 1	353 51	0 30	19 12	37 30	43 6	60 22	65 9	82 3	99 12
27	322 47	340 53	347 13	6 5	12 44	31 25	49 41	55 16	72 31	77 18	94 12	111 23
28	334 58	353 6	359 26	18 18	24 57	43 37	61 53	67 27	84 41	89 27	106 22	123 33
29	347 10	5 17	11 39	30 30	37 10	55 49	74 4	79 37	96 50	101 36	118 31	(135 43)
30	359 21	17 30	23 52	42 44	49 23	68 2	86 16	91 48	109 0	113 46	130 41	—
31	11 33	—	36 6	—	61 36	80 15	—	103 59	—	125 56	142 51	—

To find the Position of the Lunar Terminator on any Day in a Year between 1900 *and* 1999.

From Table I. take out the angle opposite the year, supposing the year to begin on March 1; *so that January and February*

must be regarded as belonging to the previous year. From this quantity subtract the angle opposite the given day in Table II., adding 360° if necessary to avoid negative quantities, an angle between 0° and 360° will be obtained, which comes under one of the four cases following:—

CASE I.—If between 0° and 90° the sum by which it exceeds 0° will be the W. longitude of the morning terminator.

Example.—Required the position of the terminator on 1900, June 1st, at midnight.

	°	′
In Table I., opposite 1900 is the angle -	89	27
In Table II., opposite June 1st is the angle (subtract) - - - - -	48	18
	41	9

Therefore the morning terminator is in 41° 9′ W. longitude.

CASE II.—If between 360° and 270°, the sum by which it falls short of 360° will be the E. longitude of the morning terminator.

Example.—Required to find the position of the terminator on 1910, July 20, at midnight.

	°	′
In Table I., opposite 1909 (it being February) is the angle - - - -	338	27
In Table II., opposite February 20, is the angle (subtract) - - -	26	10
	312	17

Subtracting 312° 17′ from 360° we get 47° 43′. which is the E. longitude of the morning terminator.

CASE III.—If between 270° and 180°, the sum by which it exceeds 180° will be the W. longitude of the evening terminator.

Example.—Required to find the position of the terminator on 1901, October 1st, midnight.

	°	′
In Table I., opposite 1901, is the angle -	319	48
In Table II., opposite October 1st, is the angle (subtract) - - -	98	28
	221	20
(Subtract) - -	180	3
	41	20

Therefore the W. longitude of the evening terminator is 41° 20′.

CASE IV.—If between 180° and 90°, the sum by which it falls short of 180° will be the E. longitude of the evening terminator.

Example.—Required to find the position of the terminator 1902, April 1st, at midnight.

	° ′
In Table I., opposite 1902, is the angle -	190 11
In Table II., opposite April 1st, is the angle (subtract) - - -	23 44
	166 27

Subtracting 166° 27′ from 180° we get 13° 33′, which is the E. longitude of the evening terminator.

To find the position of the terminator for any hour previous or subsequent to midnight subtract from the result or add to it 30′·5 per hour, which is the approximate rate at which the terminator travels towards the E.

In looking through the tables in Elger's "Moon," Mr. Crommelin detected the following errors:—

In Table I.:—

Year.			° ′		° ′
1781	-	*For*	26·2	*read*	16·2
1787	-	„	305·4	„	306·4
1804	-	„	213·35	„	213·43
1805	-	„	83·57	„	84·5
1806	-	„	314·19	„	314·28
1807	-	„	184·41	„	184·51
1812	-	„	232·13	„	232·22
1813	-	„	102·34	„	102·44
1814	-	„	332·58	„	333·6
1815	-	„	203·20	„	203·28
1820	-	„	250·49	„	250·59
1821	-	„	121·11	„	121·21
1822	-	„	351·33	„	351·43
1823	-	„	221·55	„	222·5
1828	-	„	269·26	„	269·36
1829	-	„	139·49	„	139·59
1830	-	„	10·11	„	10·21
1831	-	„	240·33	„	240·43
1842	-	„	118·17	„	218·17
1894	-	„	154·24	„	159·24
1898	-	„	347·40	„	348·40
1899	-	„	119·2	„	219·2

The important mistakes are 1781, 1787, 1842, 1894, 1898, 1899.

Mr. A. A. Williams, of Cardiff, had already called my attention to the error in the 1899 angle.

Table II. also contains following errors:—

July 23, for 320° 51′ read 323° 51′.
August 27, for 24° 1′ read 31° 25′.

WALTER GOODACRE,
Director of the Lunar Section.

PARTIAL ECLIPSE OF THE MOON, 1899.—DECEMBER 16-17.

Reports have come to hand from the following Observers:—

MR. J. H. BRIDGER, Mus.Bac., Farnborough.
MR. C. L. BROOKE, Meltham, Yorks.
MR. W. GODDEN, London, N.W.
REV. S. J. JOHNSON, M.A., F.R.A.S., Melplash, Dorset.
REV. R. KILLIP, F.R.A.S., St. Anne's-on-the-Sea, Lancaster.
MR. A. MEE, F.R.A.S., Cardiff.
MR. A. A. C. E. MERLIN, Volo, Greece.
MISS M. A. ORR, Frimley.
MR. C. PARKER, Birmingham.
MR. W. A. PARR, Florence.
MR. P. M. RYVES, Weybridge.
DR. R. J. RYLE, Brighton.
MR. C. F. SMITH, Edinburgh.
MR. H. F. SMITH, Luton.
MR. H. J. TOWNSHEND, Leeds.
MR. W. C. TETLEY, Apsley Guise, Bedfordshire.
REV. W. R. WAUGH, F.R.A.S., Portland.
MR. A. A. WILLIAMS, Cardiff.

Nearly all the reports are very detailed and comprehensive, and would occupy too much space to be reproduced *in extenso*. It is, therefore, necessary to make a digest of the same, a task which is rendered comparatively easy by reason of the marked unanimity found in them.

Weather.

The weather appears to have been of the varied character, which is usually characteristic of these events. In some few places, such as London, Birmingham, and Edinburgh, the sky was clear throughout, but in most of the others from which the reports come, clouds interfered with the seeing, either at the beginning, or in the later phases of the eclipse.

Penumbra.

				h	m
Predicted time of first contact			-	10	34
Mr. C. L. Brooke first detected penumbra at			-	11	20
Rev. S. J. Johnson	„	„	-	11	20
Mr. A. A. Williams	„	„	-	11	15
Dr. Ryle	„	„	-	10	45
Mr. Bridger	„	„	-	11	5
Mr. W. Godden	„	„	-	11	20
Mr. Merlin	„	„	-	10	50
The Director	„	„	-	11	30

Shadow (Umbra).

Predicted time of first contact $11^h\ 45^m$.

Neither Mr. Brooke nor Mr. Killip could determine with accuracy first contact with the limb.

			h	m
Miss Orr	first saw the shadow at	-	11	49
Rev. W. R. Waugh	" "	-	11	54
Mr. Mee	" "	-	11	45
Mr. H. F. Smith	" "	-	11	45
Mr. Godden	" "	-	11	46·30
Mr. Parker	" "	-	11	46
Mr. Bridger	" "	-	11	44·7
Dr. Ryle	" "	-	11	45
Mr. Williams	" "	-	11	45
Mr. Johnson	" "	-	11	45
Mr. Merlin	" "	-	11	46
The Director	" "	-	11	45

Colour and Density of the Shadow.

On these two points the reports are unanimous in stating that immediately after first contact the shadow was very dense, almost black, and seemed to predict a "dark" eclipse; at this time the limb was quite invisible to the naked eye, and barely seen in the telescope, but in a few minutes the shadow commenced to thin out rapidly, and the limb becoming visible through it, remained in sight during the rest of the eclipse. The dark edge of the shadow was followed by a zone of ashen or slatey grey colour, which in turn was followed as the eclipse progressed by a rich bright copper colour; deeper towards the centre and lighter towards the N.E. limb. It was noticed at the time of the greatest phase that for a little distance inward the limb was brighter than any other obscured portion of the disk. The most noteworthy features that struck some of the observers was the variation in the density of the shadow.

In the earlier part of the eclipse, only the coarser details of the lunar surface could be made out, but at the time of the greatest phase the smaller details could easily be seen; it was also remarkable that the rays from Tycho and Proclus were easily seen through the densest part of the shadow, which was undoubtedly at its edge.

Most of the observers timed the passing of the edge of the shadow over the principal lunar formations, some noted the time of first contact, others when the shadow crossed the centre, and others the time when the formation in question was quite covered; it would be better in future to note the time of first contact only.

After making the necessary allowances to bring the various observations to one period, we found a very marked agreement, which is shown in the following list, giving the time when these formations were bisected by the shadow—

		h	m
Aristarchus	-	11	51
Copernicus	-	12	2·5
Grimaldi	-	11	50
Plato	-	12	5
Tycho	-	12	35

Occultations.

Mr. C. L. Brooke reports:—

	D.			R.		
	h	m	s	h	m	s
BD 22°·993	12	13	53		—	
" 22·996	12	21	53	12	34	25

Mr. J. H. Bridger reports:—

	D.			R.			
	h	m	s	h	m	s	
BD 22°·993	12	14	30·5	13	33	27·5	sudden.
„ 22·996	12	20	21	13	29	23	sudden.
„ 22·1003	12	52	28·5	rather gradual.			
„ 22·1004	12	58	13	gradual.			
„ 22·1006	13	6	13	rather gradual.			

General Remarks.

In conclusion little needs adding to the foregoing details. One and all the observers agree that the eclipse was a bright one, and some point out its general resemblance to that of December 27th, 1898. It is curious that in all recent eclipses at least, the penumbra has been very faint, and these reports show that on this occasion it was not made out distinctly till some time after the predicted first contact, it may be further gathered that the penumbral shadow thins out from the edge of the umbra. Mr. C. L. Brooke states that the edge of the umbra was preceded by a fainter shadow of about 25 miles in width, whilst the Director noted that for a width of about 50 miles the edge of the shadow was a good deal darker than that which followed it, and the general appearance at the time of the greatest phase seemed to indicate that the shadow thinned out gradually from its preceding side.

Another interesting feature noticed by several was that the edge of the shadow was sharper when seen over the centre of the moon's disk than when near the limb shortly after entering upon it. Mr. Mee sends an interesting note in which he states that the outline of the shadow appeared to him to be polygonal, and that this is somewhat borne out by appearances on one of the photographs taken by Mr. A. A. Williams at Cardiff. Several observers witnessed the phenomenon of the projection of stars within the moon's limb before disappearance. Mr. C. F. Smith makes the following suggested explanation of this appearance, viz.:—

That when the telescope is in focus for a star it is out of focus for the moon's limb, and the difference is probably sufficient to cause the phenomenon in question.

In a very interesting note on the eclipse the Rev. S. J. Johnson points out that the magnitude of the eclipse on this occasion was precisely the same as the partial eclipse of October 13th, 1856.

W. GOODACRE,
Director of the Lunar Section.

Double Star Section.

The Director of the Double Star Section has received the following communication from Mr. Holmes:—

I find I have examined 329 stars in the current year, but it would serve no purpose to make out a list of the whole, as in the great majority of cases my measures coincide with previous ones within moderate limits. I propose, therefore, only to select those where I find differences sufficient to suggest the stars are worth further inquiry from observers with better micrometrical apparatus. I am well aware there may be errors in my work, but I

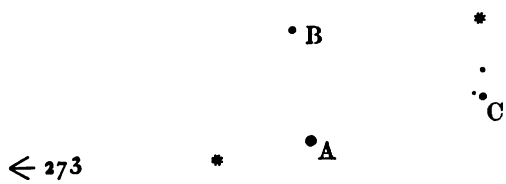
have struck out all I had marked as not satisfactory. Where I have given comparative measures they are either from Webb, 4th edition, or "Handbook of Double Stars," and are marked W. or H.

I have found OΣ 187 round and OΣ 380, and failed to see the companion to ζ Herculis. ζ Tauri also shows no sign of duplicity, nor γ^2 Andromedæ, nor 4 Cygni.

Σ 567 - - -	312° hardly able to see.	W 302°·9.
Σ 694 - - -	355° - -	W 4°·2.
Σ 749 - - -	170° est 0″·6 -	W 186°·9.
Σ 742 - - -	263° - -	W 254°·2.
Σ 750 - - -	142° - -	W 59°·2.
Σ 1426 - - -	10° and 290° -	H 11°·3 and 274°.
Σ 1643 - - -	50° - -	W 71°·2 H 54°·2.
Σ 1678 - - -	198° - -	W 211°·6.
Σ 1781 - - -	268° - -	H 250°·3.
Σ 1808 - - -	70° - -	H 76°·1.
Σ 1883 - - -	250° - -	H 259°·6 W 272°.
Σ 1908 - - -	148° - -	W 137°·2.
Σ 1932 - - -	325° - -	H 303°·5.
Σ 1931 - - -	169° - -	W 172°·5.
Σ 2120 - - -	245° est 5″ - -	W 255°·9.
Σ 2199 - - -	90° has minute star 36″ 315°.	H 100°·8.
Σ 2267 - - -	240° - -	W 231°·1.
Σ 2327 - - -	242° - -	———
Σ 2358 - - -	225° - -	W 216°·8.
Σ 2441 - - -	280° or less - -	W 291°·9.
Σ 2596 - - -	330° - -	W 353°.
Σ 2713 - - -	75° - -	W 64°·1.
Σ 2799 - - -	325° - -	W 332°·9.
Σ 3058 - - -	71° - -	W 49°·9, *qy.* error.
OΣ 228 - - -	145° obs. doubtful -	H 13°·2. There is great difference in OΣ observation.
OΣ 309 - - -	16° est only -	H 231°·5.
OΣ 313 - - -	155° - -	W 162°·2.
OΣ 311 - - -	200° - -	H 189°.
OΣ 324 - - -	230° - -	H 219°·9.
P XI III - -	170° perhaps reverse	W 345°·9.
14 Orionis - -	190° - -	W 217°·9.
P VII 170 - - -	195° est 0″·8, *qy.* error.	W 132°·9.
23 Leonis - - -	209° - -	H 223°·4.
25 Canis Ven. - -	133° - -	W 259°.
β Dephini - -	360° - -	W 14°·92.
1 - - -	360° - -	W 342°·4.
θ Draconis - -	338° - -	W 340°·8.
μ^2 Boötis - -	78° - -	W 129°.
ξ - - -	204° - -	W 282°·9.
ε - - -	331° - -	W 324°·7.
η Coronæ - -	349° badly seen 5″ elong.	W 81°·2.
η Orionis - -	87·5° - -	W 79°.
ε Hydra - - -	230° - -	W 218°.
ξ Ursæ Major - -	153° - -	W 294°·1.
λ Cassiopeiæ - -	135° - -	H 140°·7.
β 648 - - -	230° - -	H 312°·5.
β 74 - - -	325° - -	W 315°.

With regard to 70 Geminorum β gives—

A and B	98″·9	190°
A and C	161″·4	98°·5
C and D	1″·74	242°·2
C and E	17″·48	203°·3



I find a star at 315° ± and another at 195° from C estimated 85″.

I find also—

16′ Preceding	OΣ 324	A neat pair, 8″ 280° est.
38′ p 30′ N	η Coronæ	Pair, 10″ 292°.
30′ N	Σ 2443	Triple, 10″ or 12″ 313°, and faint 10°.
7′ P 1′ N	Σ 2426	Small pair.
	Σ 2428	Has C at 10° 36″.
35′ P	Σ 2247	A pair, 20″ 150°, rather brighter than 2247.
3′ P	OΣ 380	Pair, 10th and 11th, 4″ 318°.
58′ P	Altair	Pair, 9th and 11th, 6″ or 7″ 298°.
½° SP	Σ 1816	Pair, 8″ or 10″ 115°.

Variable Star Section.

The Council of the Association having asked me to take up the Directorship of the Variable Star Observing Section, I have agreed, although with a certain amount of diffidence, partly on account of becoming successor to one who is a past master both in the observation and literature of variable stars (and to whom the writer owes a debt of gratitude for much help, encouragement, and advice in this very line of work, in past years), and partly on account of being called on to "direct" some who may probably know a deal more on the subject than the Director. A third reason which weighed against acceptation of the post was the fact of having only spare hours in which to attend to the affairs of the Section, my time being largely taken up with official duties.

The first two objections are my misfortune; the third I hope to meet by strict "attention to business," even if only in spare time, for I suspect after all, most of the work of the British Astronomical Association is done in leisure moments. So much by way of preamble.

Now, as to variable star work generally. It has been often pointed out that it is a line especially adapted to amateurs; and not only adapted, but actually left for or given over to them. The public observatories, as a rule, do nothing in this way—

certainly in this country—and there is no doubt that a great field of earnest work is open to anyone who takes up this line. But how is it taken up? As a matter of fact the regular observers of variable stars in Great Britain are few and far between, and the published results correspondingly small. Sir C. Peek, of course, stands out as an assiduous worker in this department, and the Rev. Mr. Espin's discoveries of variable stars among the reds are well known. With these two exceptions I know of no regular publication of variable star results in England, except such as have appeared in our "Memoirs."

"Comparisons are odious" no doubt, but they may sometimes act like a tonic, and be of great good, if we can learn lessons from them. Looking over the past six numbers of the "Journal," which gives such a capital summary of variable star work, I note that out of 165 recorded observations of maxima and minima, 135 are made in America, leaving 30, or less than one-fifth of the whole, as due to this country. My friends of the Section, and of the British Astronomical Association generally, such things ought not to be. Now is the time to rally round our standard and start a series of observations which will bear fruit in the future in the shape of a great increase to our knowledge of the variables, for the work of observing these is essentially such as lends itself to co-operation, provided only the observations are carried out on the same system.

But let us not extend the field too much at first. It would seem best, at least for the present, to confine the work of the Section to a comparatively small number of stars. Experience shows that the amateur makes his working list far too large. I have 71 on my observing book, but since I have been stationed in England I find that I cannot do justice to them all. Mr. Knott, perhaps the most careful observer in this country, confined his list to 23 stars.

The following stars are suggested for observation, as they include nearly all the different types:—

Class.	Star.	Date of probable Maximum in 1900.
Algol type	(320) U Cephei	—
Long-period Variables	(2100) U Orionis	17 April.
	(3493) R Leonis	5 May.
	(3825) R Ursæ Majoris	7 June.
	(4511) S Ursæ Majoris	2 February.
	(4847) S Virginis	7 July.
Algol type	(1090) β Persei (Algol)	—
Irregular	(2098) α Orionis	—
Short Period	(2279) T Monocerotis	—
Irregular	(5667) R Coronæ Borealis	—
Short Period	(5758) X Herculis	—
	(6758) β Lyræ	—

(Numbers in parenthesis refer to Chandler's 3rd Catalogue of Variable Stars.)

The first six stars can only be observed in their fainter stages with a telescope. When at or near maximum they can, however, easily be picked up with a binocular.

R and S Ursæ Majoris are circumpolar stars and can therefore be observed all the year round. U Cephei at ordinary brightness is easily visible in a good binocular. It is near the Pole and therefore always visible in this country. The study of its light changes (in a telescope) when a minimum occurs at a convenient hour of the evening will prove most interesting and instructive.

Of the remaining stars Algol, β Lyræ, and α Orionis can only properly be observed with the naked eye. T Monoc., R Cor. Bor., and X Herculis require the binocular.

For the long-period variables and some of the others, the Director will prepare charts, one for each star, to show its position as visible to the naked eye, or in a binocular, and on a larger scale, the telescopic view. These, or copies, will be distributed to those who wish to take part in the work, and who may require assistance in identifying each star. There will be added the magnitudes of the companion stars, for which Prof. Pickering is in most cases the authority.

A form of recording observations will also be sent so as to facilitate the comparison of the observations.

The method of observation will be that of Argelander.

It seems no use bringing in a lot of comparison stars. Two only should be used; one a little brighter and one a little fainter than the variable at time of observation; but it occasionally happens that there is only one suitable comparison star available. The most convenient form of recording an observation seems to be as follows:—

$$2 > a, \quad 3 < b.$$

This implies that the variable was estimated at two steps or tenths of a magnitude above or *brighter than* star *a*, while it was at same time three steps or tenths below or *fainter than* star *b*.

The pamphlet "Variable Stars of Long Period," issued from the Astronomical Observatory of Harvard College, may be studied with great profit by anyone who is taking up this line of work.

Observers will kindly send in their observations at the end of each month when an endeavour will be made to work them up, and notify progress in the "Journal" from time to time.

It is requested that all present Members of the Section, as well as any who desire to join, will send in their names to the undersigned, specifying the instruments available, not forgetting the binocular.

Should success attend the proposed plan, it is hoped a larger list of stars may be prepared for the next Winter Season.

H.M. Gun Wharf,
Devonport.

E. E. MARKWICK, Colonel,
Director of the Section.

Papers communicated to the Association.

Considerations on the Double Canals of Mars.

By A. STANLEY WILLIAMS, F.R.A.S.

What is here termed the "optical theory" of the duplicated canals of Mars was first propounded some years after the discovery of the latter by Prof. Schiaparelli. By "optical theory" is here meant that theory which ascribes the observed duplications to the telescopic image being out of focus, whether directly by bad focussing, or by what has been termed "diplopia." At the time when this theory was first enunciated, I had already observed a certain number of double canals, and about this time I made numerous, and in some cases somewhat eye-torturing, experiments on Mars, with the aim of trying to make single canals appear double, or double canals single, but without success; so that I then came to the conclusion that the optical theory did not account for the observed duplications. Lately, however, the theory has been taken up by M. Antoniadi, who, with his usual energy and enthusiasm, has so exhaustively discussed and advocated it, as to put it in a fresh light altogether. Before, however, coming to any fresh conclusion upon the subject, it had seemed to me very desirable to have the opportunity of first re-examining and re-experimenting upon the planet itself, and this opportunity only occurred during the recent opposition of Mars. The foregoing outline of my experience seems to be necessary in order to explain, in part, my silence upon the subject, seeing that I am one of the few observers in England of the duplicated canals, and also because it is possible that I may be biassed against the theory, and it seems only right in the cause of truth that this possibility of bias should be acknowledged, though I am not conscious that my recent observations have been at all affected by any such bias.

It will be evident from M. Antoniadi's Interim Report of the Mar's Section, published on p. 367, of Vol. IX., of the "Journal," that my recent experiences have not been favourable to the optical theory. The conditions were seldom quite satisfactory this year as regards steadiness of definition, and the small apparent size of the planet was also adverse. Nevertheless, on two or three nights the seeing was so good, that the results appeared to me conclusive upon the subject. The canal Cerberus,* for instance, appeared continually double for more than half a-hour at a time, except when a wave of atmospheric disturbance swept over the planet and made everything appear confused. No change of focussing had any effect, beyond making the double canal appear indistinct, and ultimately to disappear. Also by no change of focussing was it possible to make a single canal appear double. When put out

* The Cerberus is represented as an *anomalously* double canal in a drawing made by Mr. A. E. Douglass in January of this year. The two lines did not appear to me to be quite parallel, but, owing to the reduced size of the planet at the time of my observation, it was impossible to be certain of this peculiarity. The diagram on p. 370 of the "Journal," is not inverted, the N. being at the top, and as it was roughly drawn from memory on a post card, it differs in some unimportant respects from the original diagram made at the time.

of focus single canals simply became indistinct, and became invisible altogether long before the optically duplicated images of a line could have separated far enough to correspond with the observed duplications of the canals. By no twisting, turning, or torturing of the eye could a single canal be made to appear double.

But it was possible to apply an even more crucial test. The glittering white polar snow cap was generally bordered by a narrow dark streak. This streak *appeared* perfectly black and definite, and in some parts of the planet it was quite narrow, so that it resembled a narrow black line drawn with pen and ink much more closely than did any canal visible at the time. But even this relatively very definite black looking streak could not be made to appear double by putting the image out of focus. The impression produced by attempting to do so, was that the image of a really perfectly black line would have to be put so far out of focus to produce the observed effects, that even the most inexperienced observer could not possibly be deceived by any such optical duplication.

Here it seems necessary to remark that too much stress has been laid upon statements that certain canals appeared as black definite lines. They may have *appeared* to the observers to be black, by contrast, but they certainly were not so in reality. Actually a very slight difference of contrast is sufficient to cause a small dark spot, or a narrow dark streak, on a large bright surface to *seem* perfectly black. An excellent illustration of this fact is afforded by the two outer satellites of Jupiter, or the largest satellite of Saturn, when transmitting the disks of their respect primaries. The disks of these planets, as is familiar to everyone, fade off considerably in brightness towards the edges. When these satellites first enter on the disks of the planets, they appear as round bright little spots. This phase is followed usually by a very short interval of invisibility, after which the satellites appear as dark spots, so dark that the two outer satellites of Jupiter are frequently described as appearing as black as their shadows. These changes of aspect are undoubtedly mainly due merely to changes of contrast, and are seen in reverse order as the satellites pass off the disk. The actual differences in contrast producing so great an effect are also inconsiderable, as experiments have shown.[1] When, therefore, we read an account of a particular canal on Mars appearing as a black line, there is nothing analogous to a really black line drawn by pen and ink; nor do experiments made by putting such lines deliberately out of focus have really any bearing upon the subject at all. There is no analogy whatever between the two things.

In the "Observatory" for June 1899, p. 227, I stated the opinion that the double canals of Mars were due in reality merely to two ordinary single canals being seen apparently close together.* In other words, such canals are simply optically double, much in the same sense as we speak of a double star being optically double. Perhaps in this connexion it may be permissible to make the following quotation from the above periodical. "If both single "canals (composing a so-called double canal) are narrow and

* Mr. L. Brenner has enunciated much the same view. *See* the "Observatory" for August 1898, p. 298.

"definite, and run nearly parallel to each other, the resulting "gemination will be perfect, the included region appearing as "bright as the exterior. But if one or both of the single canals "should be diffuse and irregular on the edges, then the included "area will appear more or less dark or shaded. This is a very "common form. Few things are better established about Mars "than the fact that individual single canals vary largely in "plainness from time to time, and sometimes apparently in "position, and a very little variation of this kind in one or both "of the adjacent single canals would suffice to cause the dupli- "cation to be apparent or invisible. Further, when a double "canal is observed with high powers under nearly perfect con- "ditions of seeing, the parallelism of the component lines is "seldom quite perfect. In other words, most double canals are "really anomalously double."

It is obvious that, according to such a definition, what constitutes a double canal would be largely a matter of individual opinion. What one observer would describe as a double canal, to another might appear as two distinct single canals. This is well illustrated by the double canal named Titan by Prof. Schiaparelli. This canal appears as a wide double canal in several of the maps and drawings published by this observer, and in 1890, it was so seen and drawn by the writer.* But in 1894, the observers at Mr. Lowell's Observatory in place of this double canal appear to have seen two separate single canals, which bear distinct names, Belus and Evenus, in Mr. Lowell's map. A comparison between the various maps and drawings will show beyond all question that the same object or objects are referred to. Somewhat similarly, what might be described by an observer as a double canal when the apparent diameter of Mars is 10″, might appear, even to the same observer, as two distinct single canals when such diameter is 20″, the appearance of physical connexion being removed owing to the larger scale. Also, what might be considered to be a double canal when the planet's S. pole is directed towards the earth, might appear as two widely separated single canals when the N. pole is turned to the earth, owing to the difference in foreshortening. And if one of the two neighbouring canals were not so plain as the other, the former might be missed by one observer, though another one might see both, and consider the canal to be a double one.†

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* *See* Flammarion's "La Planete Mars," p. 472, fig. 239.

† Observations of the double belts of Jupiter and Saturn and other analogous features seem to show that (1) Where two nearly parallel belts or streaks are observed with a power too low, or with an aperture too small, for full resolution, or under unfavourable conditions of seeing, there is a tendency to draw or describe such belts as being closer together than they really are. (2) Under such conditions of insufficient power or aperture, the components of such a double belt will often be drawn or described as equally broad and plain, although in reality they are considerably unequal in one or both these respects. (3) The components of a double belt will often be drawn or described as parallel, although in reality deviating considerably from parallelism. (4) The fact of the two belts being close together seems to cause the minor irregularities of both belts to disappear or become less conspicuous, at any rate in poor seeing, except when the irregularities on one belt nearly coincide in position with those on the other, when the result is a greatly intensified irregularity.

For these and other considerations, the fact of particular canals being described as double at one observatory and only single at another, would really have no bearing upon the reality of the observed duplications of canals, especially since the personal element enters so largely into all observations of delicate planetary detals, the visibility of which is moreover dependent so greatly upon the conditions of seeing, which are seldom the same at two different observatories at the same time.*

There seems to be an erroneous impression prevailing with regard to the small scale, or minuteness and difficulty of the double canals. Many of them are undoubtedly of the utmost difficulty and delicacy, but in a considerable number of cases the duplicity can only be described as coarse and easy. The components of the double canal Ganges, for instance, are certainly separated by considerably more than 1″ of arc† at a favourable opposition. Indeed, according to the drawings of Prof. J. E. Keeler, the present Director of the Lick Observatory, made at Alleghany in 1892, the two streaks composing this double canal were then as much as 2″ apart. The double Titan is quite as wide, the components being separated by at least 1″ at the time of my observation in 1890, above alluded to. As already pointed out, the two streaks constituting the double Titan have been considered by some observers to be two distinct single canals. Again, in 1896, the "lake" known as Trivium Charontis appeared to M. Antoniadi on a very fine night as two round black spots, which were separated by more than 1″. It would be interesting to know what our double star observers would think, were it seriously stated that with telescopes of 6-in., 10-in., 12-in., 15-in., 18 in., 24-in., and 36-in. in aperture, it was impossible to distinguish between a real double star, with equal components separated by over 1″ of arc, and illusory duplications caused by the image being out of focus! Yet such a case would be exactly on all fours with the present one.‡ Or rather the comparison would be immensely more favourable to the actuality of the duplication of the Martian canals, since actual experiment shows that a line can be perceived of much less breadth than a spot or disk,§ and atmospheric disturbances have less influence upon a line than they do upon a spot or disk.

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* The small value of negative evidence, especially in the presence of positive evidence, has often been commented on. There are very many cases on record of the same canal having been seen double at two or more observatories at about the same time. To take only the past opposition, we have, besides others, (1) Ganges, seen double by Antoniadi at Juvisy, and Cerulli at Teramo, Italy; (2) Gehon, by Cerulli and Williams; (3) Cerberus, by Douglass and Williams; (4) Nilokeras, by Cerulli, Phillips, Williams, and perhaps G. L. Brown.

† Measuring from the middle of one streak to the middle of the other.

‡ It makes not the slightest difference in this comparison, whether the image is supposed to be actually telescopically out of focus, or caused to appear as if out of focus by diplopia, or any defect in the observer's eye.

§ See an interesting article bearing on this subject by Mr. E. W. Maunder in "Knowledge," 1894, p. 251. Mr. Maunder found that the limit of vision *with the naked eye* for a circular dot ranged from a diameter of 30″ to 36″ of arc. But the limit for a straight line was as low as 7″ or 8″; a line with a breadth of 12″ being easy and conspicuous. This very suggestive article deserves careful attention, not only in connexion with Mars, but also with espect to the proper interpretation of all planetary markings.

Something has been said about the difficulty of focussing exactly on Mars, but this difficulty I have never experienced myself. There are three features upon one or other of which it is always possible to focus with as much exactness as on a double star. These are, the limb of the planet, the polar snow caps, and the borders of the more pronounced "seas" and "continents." It is possible, however, that with a refractor the correct focus for the whitish limb or brilliant white snow caps might differ slightly from that required for the reddish continental areas. This might explain the slight indistinctness of the limb referred to by M. Antoniadi on p. 371 of the "Journal" in connexion with the duplicity of the Ganges and Nilus. It is well known that in the case of the great telescopes, such as those at the Lick and Yerkes Observatories, the focus varies very considerably for the different rays, and hence there might well be a perceptible difference even with a refractor no bigger than the one at Juvisy.

It would seem that even the supporters of the optical theory regard the duplicity of one canal, the Nilokeras, as real. Yet there is absolutely no difference in appearance between the duplicity of this canal and that of many others! There is a double bay on Mars well known under the name of "Dawes' Forked Bay," the reality of which has never been questioned. There is also a double canal, the Gehon, the two components of which run from the two inlets of Dawes' Forked Bay. It seems hardly logical to admit the duplicity of the bay whilst refusing to acknowledge that of the canal.

The finer rills or clefts on the moon when filled with shadow appear as perfectly black, narrow, and very definite lines, and hence such objects ought, according to the optical theory, to be admirably adapted for giving rise to optical duplications of a similar kind to those of the Martian canals. Yet I have never heard of anything at all analogous being observed in connexion with the lunar rills, nor have I ever noticed anything similar myself.

In every theory of the kind now in question, the really crucial test must always be actual experiment upon the object itself, and it will be clear, I think, from the foregoing that the optical theory of the duplication of the canals of Mars breaks down altogether under such crucial test. Nevertheless, I do not wish it to be thought that I consider the exhaustive investigations of M. Antoniadi upon the subject as being useless or fruitless. On the contrary, besides being extremely interesting in themselves, they assist us to various important and useful conclusions. Take, for instance, his note on p. 270 of the "Journal." Here M. Antoniadi describes how an optical or illusory "lake" might appear. But the same explanation might apply to a case where the two intersecting canals were really darker along the middle and fainter on the edges, especially if the material of one canal were slightly reinforced by that of the other at the point of intersection, surely a not impossible or unlikely thing. Hence it is quite possible that some of the little dark spots or "lakes" which we see where two or more canals meet or intersect each other may have no real existence apart from the canals. But it would be rash to assume that all such dark spots are of this description, since in some cases

therè are lakes of such magnitude, that we know they must have an objective existence, however ignorant we may be of the real nature of the objects in question.

In the foregoing, I have merely touched upon a few of the questions surrounding the interesting subject of the double canals of Mars, and the optical theory by which it has been attempted to explain the same. Much more could be said upon these and other points bearing upon the subject, but the present notes have already run to too great a length, and, moreover, it seems unnecessary to further discuss the subject, seeing that the optical theory breaks down under the test of actual experiment. In conclusion, I wish to acknowledge the perfect fairness and consideration with which M. Antoniadi has treated my observations and views, notwithstanding that they are in contradiction to his own theory and opinion on the subject.

Note on Mr. Stanley Williams' Paper.

"Pending a more detailed analysis of the above (Mr. Stanley Williams's) paper, some notes on the points therein raised would not be out of use here.

"Mr. Stanley Williams concludes that 'the optical theory 'breaks down under the test of actual experiment.' But the question arises: 'Is it possible to experiment directly on Mars?' My recent inquiry into the subject has convinced me of the contrary. In fact, I studied Mars for upwards of a year in 1898–99, and with a more powerful instrument than Mr. Williams, and found it impossible to experiment on objects visible not continually, and when *I* wanted to experiment on them, but by rare glimpses only, lasting usually for very small fractions of a second, thus forcing the observer to *passively assist* at what the varying atmospheric conditions and sensibility of the retina would please themselves to show him.

"In considering the double canals as objective realities, Mr. Williams is, of course, unable to account for the fact that they appear at one and the same time single and double to different observers. In fact, the optical phenomena of a double canal, having branches of equal intensity, should be:—(*a*) twin lines; (*b*) a broad, confused shading; and (*c*) invisibility. *Under no circumstances whatever could the object appear as a narrow black line;* and that is just what has been seen. Denying these facts would be straining the results of observation in order to make them best accord with our views. But, inasmuch, as we cannot transcend experience, the objectivity of the doubling canals, contradicted as it is by observation, breaks down altogether under the weight of this argument.

"There are incongruities in the above paper which cannot resist even to the shallowest analysis. Thus, the canal Cerberus, for instance, was seen at Brighton in 1899 as two parallel lines (a gemination of which Mr. Williams felt *certain*), while Mr. Douglass, of the Lowell Observatory, described it as 'an isosceles triangle.' It is hard to see how a rectangle can appear to us as a short triangle!

"Moreover, the Rev. Theodore Phillips, M.A., F.R.A.S., saw recently a single canal, ending in a single lake, splitting before his eyes in order to return to the single form a few moments later. Supposing, with Mr. Williams, the phenomenon to have been in this case real, then the branches of the doubling canal would have fled at a distance of say 150 miles, with a speed of some 100 miles a second, keep the positions gained for a few seconds, and then return home at the same rate! I hope my scepticism on the reality of such change will be excused, seeing that they are in opposition to experience, to our notions on the polity of the universe, and to the common sense of mankind."

E. ANTONIADI.

Correspondence.

The Apparent Enlargement of Heavenly Bodies when near the Horizon.

The Report of the October Meeting of the British Astronomical Association, as set forth in the "English Mechanic" for November 3, 1899, gives me the opportunity of making some additions to my previous communication upon this subject. In order to avoid rendering that paper too cumbersome, and also to gain a definite idea of the objections it would meet, I kept in reserve the elaboration of several points which I now find myself in a position to state with more clearness. In doing so I feel that I shall be greatly aided by considering in detail the remarks of Mr. W. H. Wesley.

First of all, he is reported as speaking of my attempted explanation as "somewhat similar to the well-known suggestion "that the celestial vault does not appear to us as half a hollow "sphere, but as an ellipsoid in form; so that it is apparently "much nearer to us in the zenith than at the horizon." May I be permitted to say that I was hitherto ignorant of the suggestion he alludes to. Indeed, until a couple of months ago, I had expended very little thought upon this question of Apparent Enlargement of Heavenly Bodies, and during the writing of my previous communication I was absent from home and unable to consult the literature of the subject, or indeed of such a kindred subject as the apparent shape of the celestial vault.

At any rate, wherefore this ellipsoidal shape? Simply for this reason, that in the zenith the vault appears to be flattened down upon us. I pointed this out in my former paper, where I said that I considered it when thus viewed to contain "practically no trace of curvature." The reason I gave was that the observer's "field "of view is not extensive enough as to include an appreciable "portion of the dip of sky towards the horizon." Here then we start with an optical illusion concerning the sky in the neighbourhood of the zenith, which must needs be universal as regards human beings. And why? Because the reason for this universality will easily be seen from a consideration of the position in

which the eyes of men are placed. I do not, therefore, consider that I am making too great an assumption if I say that the *field of surrounding vision*, of which each one of us *feels himself aware* when fixing his eyes upon a given object at a given distance, may for human beings with normal sight be regarded as a "constant." I would be inclined then to look upon this appearance of "flattening" in and about the zenith, and after that the gradual and increasing outward distension of the field of view in accordance as the eyes are more lowered, as a set of optical phenomena common of necessity to all human beings, although the majority of them may be utterly unaware of the fact.

Secondly, let us consider the mental aspect of the case, for to this aspect I incline with Mr. Wesley in suspecting the cause of the illusion. I imagine that each one of us in the gradual growth of his experience, and quite unconsciously, forms with respect to the celestial vault a collection of similar "conventions" as regards the relative backgrounds to which he would refer each portion of this vault, these "conventions" being conditioned by the universal optical arrangement to which I have drawn attention above. The projections become then *for each angular height* hardened as it were in the mind (I would here like to thank Mr. L. B. Tappenden for his "Cognate illustration"), and I take it that no matter what acrobatic feats he may perform, so as to view celestial objects under changed conditions, and no matter how much of horizon he may exclude from his vision, the observer will (unless taken completely unawares, and then the deception will be but fleeting) unconsciously refer the objects in question to the conventional relative projections to which I have alluded above.

I therefore propose to explain this question of the gradual Apparent Enlargement of Heavenly Bodies in their descent towards the horizon, as *an illusion founded upon a collection of mental conventions, identical in normal human beings, and directly conditioned by the similarity of structure in their optical apparatus.* In a word, the unvarying physical setting of the eyes of men would necessarily give rise to a certain set of like judgments concerning the background of the sky, which when once formed would tend to become what is called "second nature." [I would here refer the reader to the consideration of Locke's "Essay on the Human Understanding," Book II., Chap. IX. (of Perception), Sections 8–10.]

The foregoing remarks will, I think, explain the observations of M. Stroobant as related by Mr. Maunder. The observer, standing at the centre of a large dome, would be *exactly situated* as beneath the celestial vault; and would, I presume, as regards lights or objects placed around the former, unconsciously apply the conventional system of projection above alluded to, in the same way that he would instantly appreciate the sphericity of a ball seen from a distance, quite irrespective of the actual size of the ball.

CECIL G. DOLMAGE.

22, Upper Merrion Street, Dublin,
November 11, 1899.

In the recent number of the "Journal" of the British Astronomical Association is a brief account of the discussion which took place at the Meeting of the 25th October last, as to the apparent enlargement of heavenly bodies when near the horizon.

Several suggestions were referred to as having been offered by way of explaining that seeming effect, among them being one stated by Sir J. Herschel in his Elementary Treatise on Astronomy, namely, that it arose from a comparison with objects on the earth. Sir J. Herschel had said it could be seen to be so by partly closing one's hand so as to form a kind of cylindrical aperture, and by looking through it at the setting sun, or other heavenly body near the horizon, and thus shutting out all terrestrial objects, the object would appear to be of its ordinary size.

At the Meeting mentioned it was contended on amply justified data that the enlarged appearance was not thus caused, and it seems to have been concluded that no explanation of the phenomenon had hitherto been substantiated.

The remarks of all the Members who spoke upon the subject appeared to be based upon the idea that the seeming enlargement is due to some cause that is more or less extra-tellurian, such as the action of the earth's atmosphere, or the form of the sky-dome surrounding our globe.

But another suggestion that seems almost self-obvious was not put forward by any of the speakers, namely, that it is more than probably occasioned by the external form and internal structure of the instrument employed in beholding it, that is to say, the eye itself.

Each ray of light coming from the object may be regarded as so coming in a straight line direct to the outer surface of the eye, whether quite horizontally, as in the case of the sun at sunset or sunrise, or more or less vertically from any part of the sky-dome between the horizon and the zenith.

In proportion to the body being higher or lower in the heavens so are the rays closer together or further apart from each other.

From the spots at which they make impact with or form angles of incidence on the surface of the eye, they pass at the same angles into and through the humours and other media, including the lens, whereof the inner portions of the eye consist, until they reach that marvellous point in the retina whence the brain receives all its eye-images.

Those eye-images are exactly what are produced by the optical functions of the eye, that is, they appear larger when viewed horizontally than when seen at a height above the horizon, and proportionately with the increase of that height, their size seems to become diminished.

No attempt is here intended to be made at describing the full details of the *modus operandi*, whereby is finally attained the effect of mentally discerning the image of any luminous object upon which our visual organs may happen to look. It appears sufficient to suggest that the eye, like every other organisation in nature's illimitable domain, is perfectly adapted for all the functions assigned to it.

As connected with our powers of physical vision, however, one or two circumstances may be regarded as having an interest

How does it arise, for example, that the sky appears to be concave, or nearly so? Of course the answer is plain. It is because our powers of vision extend to one and the same distance in every direction in which we gaze skyward. The eye, or rather, that point in its structure at which all our eye images are formed, and are hence conveyed to the brain, is the centre where are converged all of what may be designated the distance-radii of the sight. What that distance may be is obviously various, depending as it does upon the conspicuousness of the object looked at, and upon the conditions of the etheric medium through which we gaze. So far as regards the globe's surface the eye is capable of seeing a brilliant object through a sufficiently clear atmosphere, for a distance of 25 miles or more, as from the cliffs at Dover, for instance, to and beyond the coast-line of France, while, gazing skyward on a clear night, it can discern objects at hundreds of millions of times that distance.

When, therefore, we look towards the particles whereof the blue sky may be supposed to consist, it is logically obvious that our power of vision being identically the same in every direction, reckoning it from the centre where our eye-images are formed, that the medium through or into which we gaze must, at the further extremities of that power, present to us the appearance of circular concavity, or as the interior surface of a sphere or dome whereunder the innumerable star-spots we behold seem to be located.

Everybody has no doubt observed what may be deemed an incident in the question under discussion, that sometimes when the sky is obscured by thick clouds, the medium comprising the cloud-masses above us does not present the appearance of concavity at its lower surface, the reason being, of course, that it is there within the range or radius of our sight-power. Hence, it may be presumed that the clouds are low-lying, and the inference seems to follow that rain may then be expected.

2nd December 1899. R. G. M. BROWNE.

Occultations observed during Partial Lunar Eclipse of 16th–17th December 1899.

The eclipse was very well seen here, from commencement to greatest phase. The following observations were made with a 5-in. "Cooke" equatorial, power about 90, and a mean time chronometer:—

Times of Passage of Shadow over Lunar Formations.

h	m	s	
11	49	30	Shadow reached Aristarchus.
11	55	45	" " Kepler and Heraclides.
12	2	0	" " Copernicus.
12	4	49	" " Plato.

The above times are, of course, only approximate, as the shadow has no definite boundary. No further times of passage

of the shadow were taken, as time of first occultation was drawing near.

Near greatest phase it was noticed that moon's disk glowed with a ruddy light *except* near the boundary of the shadow, where it was of a blackish or smoky hue.

Occultations.

Star.	Mag.	Phe-nom.	Calculated Time.	Posn. ∠ from North Point.	True Time.	Remarks.
			h m s	°	h m s	
B.D. 22·993	8·1	D	12 12 30	79	12 12 34	Observed Position ∠ seemed 109°.
22·991	8·6	D	12 20 48	43	12 18 22·5	
22·999	9·0	D	12 22 12	67	12 22 13·5	
22·996	6·5	D	12 23 48	52	12 23 12·5	
22·1000	8·5	D	12 25 12	118	12 25 14·5	
22·998	9·5	D	12 28 48	43	—	Did not notice star near this position.
Unknown	±8·5	D	—	±115	12 46 38	B.D. 22·1003? Pos. ∠ only estimated.
"	±9·5	D	—	±120	—	Too faint to note time of disappearance.
B.D. 22·1004	8·3	D	13 2 36	36	13 2 41·5	
22·991	8·6	R	13 4 48	328	13 5 35·5	Time of re-appearance doubtful.

Fog and cloud prevented further observation.

The calculated times and places are those for the Royal Observatory, Blackford Hill, Edinburgh, and the true times are the observed times corrected for the error and rate of chronometer, and they can be depended on to ·5 of a second, except in the case marked doubtful.

As has been noticed on many previous occasions, the stars all seemed to be sensibly within the eclipsed moon's limb before being occulted.

Edinburgh. WM. M. BAXTER.

Queries.

Query No. 51. OCCULTATION OF NEPTUNE.—Would it have been possible to observe the occultation of Neptune on the 19th November (when the moon was nearly full), in a 3-in. aperture telescope? Or would the brightness of the moon prevent Neptune being seen?

Reply.—It would not have been possible to observe the occultation at the bright limb, and probably not possible to observe it at all.

Query No. 52. METEORS ESCAPING THE EARTH'S ATMOSPHERE.—Is it theoretically possible that meteors which just escape entering the earth's atmosphere and being destroyed by it, could be deflected from their orbits and detained by the earth as invisible satellites? Or is their velocity sufficient to prevent this?

Reply.—It would not be possible for any meteor moving in a parabolic or approximately parabolic orbit to be captured by the earth as a satellite. A meteor moving in an elliptical orbit in the same direction as the earth might conceivably be so captured, but such an event would be very rare, and the meteor would move in an elongated ellipse, its motion being very unstable.

Query No. 53. REFLECTING TELESCOPE. — Where can I find full instructions as to the mode of making a small reflecting telescope?

Reply.—Consult a file of the "English Mechanic," and if you cannot thus find what you want address a special query to that paper.

Query No. 54. EARTH'S MEAN DISTANCE FROM THE SUN.—With reference to the earth's mean distance from the sun during each lunation, when is it that the earth is nearest to the sun? Is it at new moon or full moon?

Reply.—So far as the effect referred to above is concerned, the distance earth—sun is least at full moon.

Query No. 55. TESTS FOR 2-IN. TELESCOPES.—Can you give me any crucial tests for 2-in. home-made simple telescope? I wish to make sure that the lenses are mounted square with tube, and that their centres are in a straight line?

Reply.—Refer to Sadler and Clark's "Star Guide." There is a copy in the library of the Association.

Query No. 56. OXYGEN IN THE SUN.—A few years ago the President of the British Association for the Advancement of Science, stated that there was no oxygen in the sun. Does that view prevail at the present day. Speaking of flame generally, is it true that it is the burning of gases? And when we see flame, are we warranted, in general, in saying there is oxygen there? Is there evidence of the flames in the sun being differently constituted from flames on the earth? Or are we warranted in saying of the flames in the sun, there is oxygen there?

Reply.—The essential idea in flame is the presence of highly heated gas. Here on the earth flame mostly results from combustion, *i.e.*, from the energetic combination of two or more substances, one of which is nearly always the element oxygen. The temperature of the sun so far exceeds anything produced by terrestrial combustions that we cannot ascribe the generality of solar flames to such action. It is at present doubtful whether oxygen has been shown to exist in the sun. Some lines belonging to oxygen have possibly been observed as solar lines, while some of the oxygen lines in the *a* group seem to have been widened in the spectra of sun-spots. The question as to the nature of solar flames is also unsettled. They consist mainly of hydrogen and helium, and at their bases the vapours of heavier metals. Some observers are of opinion that the flames are caused by the lighting up of matter already *in situ*, and not by the rising of incandescent vapours from the solar limb.

Query No. 57. LIGHT ON CLOUDY NIGHTS.—On some cloudy nights in winter when the moon is below horizon, there is still a certain amount of light. Is this light just star-light?

Reply.—Certainly not.

Query No. 58. SIRIUS EQUATORIAL.—Is the "Sirius Equatorial Head" advertised in the "Journal," satisfactory for a 4 in.?

Reply.—We cannot answer questions of this kind. Apply to the makers.

Query No. 59. ATMOSPHERIC TIDES.—Have daily tides in the earth's atmosphere ever been observed? Presumably a tidal wave of air must follow the moon just as a tidal wave of water does?

Reply.—A regular diurnal tide in atmospheric pressure is observed, which is greatest in amount at the equator and diminishes in extent towards the poles. In the annual mean curve the principal maximum occurs about 10^h a.m., and the principal mimimum at about 4^h p.m., and secondary maximum and minimum values occur at 10^h p.m. and 4^h a.m. respectively.

"There is also a small fluctuation in atmospheric pressure depending upon the position of the moon, but this is exceedingly minute. It may be stated that near the equator the pressure of the atmosphere is about 0·008 inch greater when the moon is on the meridian than when it is six hours from the meridian, and that in higher latitudes the difference of pressure is much less. These results appear to indicate a feeble tide in the atmosphere similar to those of the ocean."—"LOOMIS."

Query No. 60. LAG OF EARTH'S ATMOSPHERE.—Is it known whether the whole of the earth's atmosphere keeps pace with the earth's diurnal rotation? Have balloonists had any reason to suspect a lagging behind in the atmosphere when they have ascended a few thousand feet?

Reply.—It is presumed that the atmosphere participates in the earth's diurnal rotation. Nothing has ever been discovered by aëronauts (at any elevation above the earth's surface), which could lead them to suspect a lagging behind of the earth's atmosphere, and, indeed, it is difficult to see how such an effect could be determined.

Notices of the Association.

The ordinary Meetings of the Association will be held on 1900, January 31, February 28, March 28, April 25, May 30, and June 27.

Variable Star Section.

The Council desire to inform the Members of the Association that they have appointed Col. E. E. Markwick, F.R.A.S., Her Majesty's Gun Wharf, Devonport, Director of the Variable Star Section. The attention of the Members is directed to Col. Markwick's address, which appears on page 112 of the current number of the "Journal."

Queries.

It is requested that queries be written on one side of the paper only, and each query on a separate sheet.

Queries may either be placed in the Query Box at the Meeting, or may be sent to the Hon. Secretary, Mr. W. Schooling, F.R.A.S., Fairholme, Christchurch Road, Surbiton.

Candidates for Election as Members of the Association.

31 JANUARY 1900.

GAVIN JAMES BURNS, B.Sc.,
Kendal House, Holland Road, Weymouth.
Proposer—T. Chappell. *Seconder*—L. T. Oldneve.

WILLIAM BRAYTON DODD,
Newtown, Whitehaven.
Proposer—Henry Wake. *Seconder*—Thos. Gordon.

WILLIAM SAUNDERS EDWARDS,
Thornleigh, Bradpole, Bridport.
Proposer—Samuel J. Johnson. *Seconder*—Tyson Crawford.

MISS ALICE EVERETT, M.A.,
11, Leopold Road, Ealing Common, W.
Proposer—A. M. W. Downing. *Seconder*—W. H. Maw.

R. COWARD JOHNSON, F.R.A.S.,
7, Sweeting Street, Liverpool.
Proposer—F. W. Longbottom. *Seconder*—E. W. Maunder.

JOHN McLENNAN,
Harbour Cottage, Dingwall, N.B.
Proposer—James T. Pope. *Seconder*—R. McLean.

ERNEST RABONE,
35, Avenue Road, Highgate, N.
Proposer—Aloysius Verinder. *Seconder*—Tyson Crawford.

New Members of the Association.

ELECTED 27TH DECEMBER 1899.

ALFRED CONWAY BISHOP, 41, Thurlow Square, S.W.
SCRIVEN BOLTON, 24, Kensington Terrace, Hyde Park, Leeds.
CAPT. URIAH COOKE, 49, Drakefell Road, Nunhead, S.E.
HENRY JOHN LLOYD, 11, New Walk Terrace, York.
MISS IRENE MAUNDER, 18, Walerand Road, Lewisham Hill, S.E.
WILLIAM NORRIE, Cairnhill, Turriff, Aberdeenshire.
WILLIAM THOMPSON, J.P., Walton Grange, Stone, Staffs.
HENRY WYLES, L.D.S., 155, Woodhouse Lane, Leeds.

North-Western Branch.

NEW MEMBER OF THE ASSOCIATION.

Elected 6th December 1899.

L. MAKINSON, Grove Terrace, Higher Broughton, Manchester.

West of Scotland Branch.

NEW MEMBERS OF THE ASSOCIATION.

Elected 15*th December* 1899.

JOHN BRYCE, C.E., 20, Balshagray Avenue, Partick, Glasgow.
MR. JEFFREY, 29, St. Andrews Street, Glasgow.
THOMAS MACHELL, 1, Burnbank Terrace, Glasgow.
WILLIAM MCINTOSH, 21, Hartington Gardens, Partick, Glasgow.
JOHN THOMSON, I.A., 4, Hillend Gardens, Partickhill, Glasgow.

East of Scotland Branch.

NEW MEMBER OF THE ASSOCIATION.

Elected 16*th December* 1899.

ANDREW NICHOLSON, S.S.C., 1, Hatton Place, Edinburgh.

Erratum.

Vol. IX., p. 166, line 16 from foot of page, *for* N. limb *read* S. limb.

New Books and Memoirs.

Stars and Telescopes: By David P. Todd.

This latest addition to the ranks of "Popular Astronomies," a volume of some 420 pages, is founded on the 9th edition of Lynn's "Celestial Motions," the portions of the work due to each author being indicated throughout the volume. Written to "meet an American demand for a plain and "unrhetorical statement of the astronomy of to-day," it may at once be said that it worthily fulfils its purpose. The scope of the work is considerably wider that its title would at first lead one to suppose, and is best indicated by its sub-title "A Handbook of Popular Astronomy," since it contains chapters on the earth and moon, the solar system, eclipses, the calendar, &c., as well as on the constellations, comets, the fixed stars, and telescopes and observing instruments generally. For a brief chapter of an historical character on the Cosmogony, Dr. See is mainly responsible. A noteworthy feature is the large number of portraits scattered throughout the book of famous astronomers and others who have advanced the science. The illustrations, of which there are some 250, also comprise pictures of the chief observatories of the world, but they are, on the whole, scarcely up to the standard which we have been led to expect from America. The book itself shows evidence of careful preparation, and the information it contains is not only accurate but complete to the time of going to press. It is, however, to be regretted that Mr. Todd should, in the chapter on the moon, have adopted the word "rill" used by Mr. Lynn to denote the white streaks which radiate from some of the lunar craters. Mr. Lynn further alludes to these streaks (or rays as they are more generally termed) as having only been noticed in comparatively recent times. This is, of course, true of the rills, but the white rays cannot have escaped the notice of the very earliest users of the telescope. We find it difficult, too, to agree with Mr. Todd that the theory which accounts for these rays by attributing them to the impact of meteorites which has splashed white volcanic dust in all directions, "seems plausible." The objection that they extend in some instances over considerably more than half a hemisphere is too obvious to allow this theory even the merit of plausibility. Those readers who wish for a concise and comprehensive survey of modern astronomy, will find their wants adequately supplied in this volume, while to those who may desire to further prosecute their studies of any particular branch of the science the list of works appended to each chapter should be of valuable assistance.

Notes.

THE ROYAL ASTRONOMICAL SOCIETY.—The Society met in Burlington House on Friday, December 8, 1899. Prof. G. H. Darwin, *President*, in the Chair. *Mr. Newall* read three papers by Prof. E. E. Barnard relating to the probable motion of the annular nebula in Lyra; to the exterior nebulosities of the Pleiades, and to the involved nebulosities of the cluster as seen in the 40-inch Yerkes refractor, and to the diameter of Vesta. The motion of the ring nebula was deduced from the comparison of measures by Mr. Burnham with the 36-inch Lick refractor, and of Mr. Barnard's measures in 1898–9 at Yerkes. *Dr. Rambaut* asked if the measures were made on photographs or directly in the telescope, and he pointed out that photographs seemed to clearly indicate that the central star is part and parcel of the ring nebula, and he further asked if the measures were continuous enough for the parallax of the nebula to be ascertained from them. *The President* and *Mr. Newall* then discussed Prof. Barnard's method of using the focus reading of his telescope to measure the kind of light emitted. *Mr. Newall* saying that he believed he himself was the first to make an observation of the kind on Nova Aurigæ. *Mr. Cooper, Capt. Noble*, and *Mr. Seabroke* spoke of the uncertainty attaching to Prof. Barnard's conclusions, which *Mr. Lewis*, on the other hand, strongly supported. *Mr. Ellis* then read a paper on "The Relation between Magnetic Disturbance "and the Period of Sun-spot Frequency," and *Capt. Noble*, who had taken the Chair, and *Mr. Dyson* commented upon it. *Mr. Dyson* then exhibited photographs of the Orion nebula, and of the Pleiades taken at the Royal Observatory, Greenwich, and *Mr. Dyson, Dr. Rambaut, Mr. Newall*, and *Mr. Lindemann* gave some account of the observations, such as they were, that had been made of the Leonids.

COMET NOTES.—**A.N.**, 3605, contains an article by Dr. E. Strömgren on the cosmogony of comets. He quotes Herr Thraen's researches on the Comet 1886 II., which had a decidedly hyperbolic orbit while in the neighbourhood of the sun, but which Thraen showed had been moving in a parabola four years before, and earlier still in an ellipse. He gives reasons for supposing that a similar result would be obtained if the planetary perturbations for a long period were computed for other comets for which hyperbolic orbits have been deduced. Hence he considers it probable that no comets have hyperbolic orbits before entering the planetary system, and that comets belong originally to our own system, and do not, as a rule, approach it from other systems. He points out that the planets can influence cometary orbits in two ways, viz.: (1) by their direct action; (2) by their action on the sun. Some computers appear to have overlooked the latter point. Jupiter and Saturn may sensibly affect a comet's orbit in this manner, even when the comet does not approach them at all closely.

Mr. Frederick H. Seares has investigated in **A.N.** 3606–7 the definitive orbit of Comet 1894 IV. (E. Swift), whose identity with De Vico's Comet is probable. The comet was discovered on

1894, November 20, and observed till 1895, January 29. The following are the final elements after applying planetary perturbations:—

Epoch 1894, December 1·0; Osculation, 1894, December 10·0, Berlin M.T.

$$\begin{aligned}
M &= 8^\circ\ 22'\ 58''\cdot 2 \pm 4''\cdot 2 \\
\left.\begin{aligned}
\pi &= 345\ \ 23\ \ 11\ \cdot 1 \pm 4\ \cdot 4 \\
\Omega &= 48\ \ 48\ \ 23\ \cdot 4 \pm 27\ \cdot 7 \\
i &= 2\ \ 57\ \ 55\ \cdot 8 \pm 1\ \cdot 4
\end{aligned}\right\} & 1900\cdot 0 \\
\phi &= 34\ \ 51\ \ 37\ \cdot 3 \pm 7\ \cdot 1 \\
\mu &= 605''\cdot 9999 \pm 0''\cdot 0665
\end{aligned}$$

Mr. Seares proposes to re-examine the question of the identity of this comet with that of De Vico, taking the above definitive elements as his starting-point.

A.N. 3607, also contains some observations of Tuttle's Comet, 1899 III., made at the Cape Observatory by Mr. Innes. The following are some of the observed positions:—

Date.	G.M.T.	Appt. R.A.	Appt. S. Dec.
	h m s	h m s	° ′ ″
1899, June 26	5 24 17·5	7 59 30·21	17 3 8·8
July 1	5 16 44·4	8 17 55·64	19 25 31·8
2	5 25 21·7	8 21 40·86	19 52 45·5
6	5 16 14·2	8 36 35·18	
10	5 25 52·9	8 51 41·28	

The comet was exceedingly faint, and the observations are not considered good. On several days the only possible way of observing it was by using the field of the eye-piece as a ring-micrometer.

Minor Planet Notes.—Mr. H. N. Russell (**A.J.**, 473), and Signor Millosevich (**A.N.** 3609) have both published revised elements of (433) Eros. The latter are probably the most accurate, as he uses all the observations made in 1898–99, and applies perturbations. We give below (I.) Russell's elements for the apparition of 1898, referred to the equinox of 1898·0. (II.) Millosevich's elements for the apparition of 1898, referred to the equinox of 1900·0. (III.) Millosevich's elements for the next apparition referred to the equinox of 1900·0.

—	I.	II.	III.
Epoch	1898, Aug. 31·5 G.M.T.	1898, Aug. 2·5 Berlin M.T.	1900, Oct. 31·5 Berlin M.T.
M	221° 37′ 2″·0	205° 22′ 27″·98	304° 23′ 59″·7
ω	177° 39′ 10″·6	177° 38′ 39″·02	177° 38′ 41″·6
Ω	303° 29′ 57″·3	303° 31′ 46″·59	303° 30′ 40″·4
i	10° 49′ 31″·0	10° 49′ 35″·30	10° 49′ 38″·9
φ	12° 52′ 14″·2	12° 52′ 21″·99	12° 52′ 48″·2
μ	2015·″2326	2015″·16324	2015″·12740
log. a	0·1637876	0·1637975	0·1638027

Millosevich gives an extended ephemeris for the next apparition, from which we give the following extract (reduced to Greenwich midnight).

Date.	R.A.			N. Dec.		Distance from Earth.	Magnitude.
	h	m	s	°	′		
1900, Nov. 10 -	1	56	17	54	18	0·3743	9·04
18 -	1	41	4	53	34	0·3534	
26 -	1	30	17	51	49	0·3379	8·76
Dec. 4 -	1	26	9	49	18	0·3269	
12 -	1	29	7	46	17	0·3199	8·55
20 -	1	38	43	42	59	0·3161	
28 -	1	54	7	39	35	0·3155	8·45
1901, Jan. 5 -	2	14	16	36	9	0·3175	
13 -	2	38	2	32	44	0·3221	8·46
21 -	3	4	27	29	22	0·3296	
29 -	3	32	48	26	4	0·3400	8·54

It is interesting to note that Eros made a close approach to Mars on October 26 last, the distance being 0·28, while the least possible distance of the two planets is 0·24. Such a close approach is very rare, as their synodic period is no less than 27·59 years, and at most conjunctions their distance apart is considerably greater than the above.

Another new planet, EY, of the 10th magnitude, was discovered by M. Charlois at Nice on December 4.

The orbit of the new planet ER shows some resemblance to those of the lost planets (99) Dike and (155) Scylla. Identity with one or other of them is not impossible.

Another planet, EZ, was discovered by Mr. Coddington at the Lick Observatory in October, but this is considered to be certainly identical with planet (415) which was recently sought for by Palisa without success.

Planet EW proves to be identical with (110) Lydia. Planet (355) has been named Gabriella, and (387) Aquitania.

"THE INDIAN ECLIPSE, 1898. — *Wave-length Scales for Eclipse Spectra.*—The slip enclosed in this number of the "Journal" is intended to be used for the identification of the more prominent lines in the spectrum photographs published in the Report on the Indian Eclipse.

Two scales are given, one for use with the combined flash and cusp spectra, the last of the series of plates, and the other for the flash spectrum, plate No. 3. As the other spectra are very nearly similar to No. 3, the scale for the latter can be used for them also.

The necessary data for the construction of these scales were not available when the plates were made, and it was not possible, therefore, to print the scales above the spectra to which they correspond. It is hoped that this separate slip will supply the omission, and be of assistance to those who desire to examine the plates in detail.—J. EVERSHED.

Astronomical Publications.

The Constituents of the Sun. *A. Fowler.*—The sources from which information relating to the solar elements is obtained are described, and attention is drawn to the point that there may be still unrecognised elements among the constituents of the terrestrial crust existing in such small quantities as to evade the ordinary forms of chemical analysis. Until a spectroscopic comparison has been made with the sun of substances as they occur naturally in the form of minerals and rocks it would be unwise to conclude that the thousands of unidentified Fraunhofer lines in the solar spectrum owe their origin to non-terrestrial matter. Lists of the probable and suspected solar elements are given, and Prof. Rowland's remark, that, "were the whole earth "heated to the temperature of the sun its spectrum would "probably resemble that of the sun very closely," is quoted as being, probably, not very far from the truth. (**Kn.**, Jan. 1900.)

The Rotation of Venus. *Abbé Th. Moreux.* — Examines and endorses the ideas enunciated by M. Antoniadi in a paper published in the "Monthly Notices," Royal Astronomical Society, Vol. LVIII., p. 317, and which may be resumed as follows:— (*a.*) The scattering of light by the atmospheric particles of the planet hides all surface markings from our view; (*b*) The symmetrical shadings seen on the dichotomized disk are very likely mere contrast effects; (*c*) under such circumstances we are not authorised to pronounce ourselves in favour of any rotation period whatsoever. Abbé Moreux then examines mathematically Lambert's law, and gives his own theory of the exaggerated cusps, published in Vol. VIII. of the "Journal." (**B.A.F.**, August 1899.)

The Shadow cast by Venus. *E. Touchet.*—By fixing an ordinary camera, without its objective, at the eye end of a small telescope, the writer secured a fine photograph of the shadow and diffraction bands cast by an object occupying the position of the removed glass, and exposed to the rays of the dazzling planet. (**B.A.F.**, September 1899.)

Mars. *Rev. T. E. R. Phillips.*—The number of nights when useful observations could be made showed a decided increase on the corresponding number during the previous apparition. The N. polar cap was large and intensely bright up to the close of observations in April, the outline being fairly regular, and its edge always sharply defined. Although the S. polar cap was invisible, a whitish glimmer frequently illuminated the S. limb. On March 1, a new lake was detected S.E. of Niliacus Lacus; and towards the end of February, an exceedingly white spot about lat. 50. A dusky spot was also seen at times at S. end of Ceraunius. The large dark region in the neighbourhood of the Boreosyrtis was a most remarkable feature. The "canals" seen were fewer in number. (**M.N.**, November 1890)

OBSERVATIONS OF MARS. *V. Cerulli.*—Three drawings showing the Syrtis Major and Mars Sirenum regions, but whose characteristic is a marvellous over-refinement of numberless delicate "canals" and "lakes," accompany a short note by the writer, who concludes that "decidedly, the canals are not physical "lines, but optical products, that is to say, lines of deeper shade, "revealing to us the existence of all these details of the Martian "surface which lie beyond the reach of our present telescopes." (B.A.F., August 1899.)

MARS IN 1899. *C. Flammarion* and *E. Antoniadi.*—The writers give the results of their observations from 1899, February 17, to July 30. "The lack of details of our last drawings," it is said, "when the disk of the planet was under 8″, is note-"worthy. But we never departed from the principle of drawing "only what we were seeing with certainty. The results thus "acquired are surely less brilliant than those of some other "observers, but, perhaps, also more truthful." The diminution of the N. polar cap was carefully followed for over eight months:—

Date.	N. Cap's Diameter.	Date.	N. Cap's Diameter.	Date.	N. Cap's Diameter.	Date.	N. Cap's Diameter.
1898. Oct. 22	° 60	1899. Jan. 25	° 50	1899. Feb. 17	° 42	1899. Mar. 14	° 35
Nov. 11	55	Feb. 2	46	„ 20	48	„ 16	36
Dec. 20	42	„ 4	46	„ 24	40	Apr. 19	30
1899. Jan. 8	42	„ 10	41	„ 27	40	May 30	25

The most remarkable changes seem to have occurred in the Boreosyrtis region. The whitening land about the limb showed nothing abnormal. An interesting deduction of the writers is the blackness of the sky to an observer on the planet, a phenomenon due to the extreme tenuity of the atmosphere, and rendering faint stars visible in broad daylight A large number of drawings accompany the Memoir, together with a chart of the planet, 1898–99, showing 36 canals, as broad indefinite shadings. (B.A.F., September, 1899.)

JUPITER. *Joseph Gledhill.*—Adopting the nomenclature of the British Astronomical Association, Band 0 was a narrow easily seen grey band. Band 1, in general, grey and strap-like, varying considerably in breadth and tone. Band 2 was almost featureless, becoming paler and narrower shortly before the red spot reached the central meridian, when the bright space between 2 and 3 would grow wider. The principal features of the double band (4, 5) were diffuseness along N. edge of 4 and dark spots on 5, with sharpness of its S. edge. Bands 6 and 7 were usually far from conspicuous. With respect to the red spot, neither colour nor shading was seen within the ellipse. On all occasions it was noted that the parts of the disc to the S. of Band 2, were much brighter than those to the N. of Band 5, and the zone between 1

and 2 was the brightest of all. Between dark Bands 3 and 4, a narrow band was nearly always seen. (**M.N.**, November 1899.)

OBSERVATIONS OF JUPITER. *C. Flammarion.* — This is an abridged, though fairly complete, review of the most recent investigations. The various currents, drifting along the visible surface of the planet, are first examined, then follows a discussion of the varying period of rotation of the self same currents, of the slackening motion of the spots situated in the equatorial zone and of the "red" spot, the latter according to Mr. Denning's inquiry. The paper is accompanied by six views of Jupiter in 1898 by M. Antoniadi, as well as by two diagrams of the "red" spot region. The longitude of the "red" spot, which coincided with Mr. Marth's zero meridian in 1894, was found by the Juvisy observers to be 23°·6 on 1898, May 21, 26°·0 on June 5, and 27°·2 on June 12. (**B.A.F.**, August 1899.)

THE NOVEMBER METEORS. *Dr. W. J. S. Lockyer.*—Nearly all accounts show a dearth of Leonids. The first Paris balloon ascent on the morning of November 14–15 showed an increasing hourly number, reaching 40 between 5 a.m. and 6 a.m. In the second ascent the next morning only eight were observed between $1^h\ 20^m$ and 6^h a.m. At Strasbourg, the maximum rate was 60 per hour at 6 a.m. on the 15th, which is the greatest so far recorded. Two accounts are given of daylight observations of meteors, but the accounts show that they certainly could not have been Leonids. (**Nat.**, December 7.)

SUPPOSED DAYLIGHT LEONIDS. *W. F. Denning.*—Referring to Dr. Lockyer's details, Mr. Denning has no doubt that the objects were entirely imaginary. A similar appearance may be easily produced by bending the neck and gazing intently for a few minutes at a bright sky. He calls attention to an account in the "Daily Chronicle" of November 25, stating that the astronomers at Vienna saw 67 meteors, mostly Andromedids, and obtained 12 photographs.

NON-APPEARANCE OF THE EXPECTED LEONID SHOWER. *W. H. Pickering.*—Since 1698 the shower has appeared with considerable regularity at intervals of 34 years. Showers were seen in 1866, 1867, and 1868. If we adopt 1867 as the main shower, the next should be due in 1901; but local evidence indicates that 1868 was the finest of the three, and if so, its return may be looked for in 1902. This point of view indicates that there was little reason to expect the return before 1900. (**P.A.**, December.)

THE LEONIDS OF NOVEMBER 1899. *W. W. Payne.*—At Harvard, 50 were recorded; Chicago, 30; Denver, 18 (in 15 minutes before 2 a.m.); Kansas City, a fairly large number; Wichita, a few; Princeton, no general shower; Washington, a few only; Minneapolis, a scant number; Northfield, 20; Berlin, a considerable shower; India, a few. The results were disappointing. (**P.A.**, December.)

A SHOWER OF BIELIDS. *C. A. Young.*—A well-marked shower was observed at Princeton between $14^h\ 30^m$ and 16^h G.M.T., corresponding to $9^h\ 30^m$ and 11^h local time. Between

10 and 11 Prof. Young counted 42, and fully as many in addition were seen by two other observers standing near him. The shower seems to have begun pretty sharply between 9^h 15^m and 9^h 30^m. It was difficult to determine the radiant accurately, but it was an area 2° or 3° in diameter, approximately at R.A. 1^h 32^m Dec. + 42° $15'$. (P A., December.)

STELLAR MAGNITUDES. *H. H. Turner.*—It appears that as regards the fainter stars the variation of personal equation is different for different observers; but a more hopeful result was obtained for the brighter stars on comparing Cambridge and Greenwich. How far the habits of observers remain constant is yet to be determined. The personality in R.A. may be described by saying that to magnitude 8·0 or thereabouts, bright stars are observed too early by $0^s \cdot 023$ per magnitude. For stars fainter than 8·0, the personality increases rapidly to $0^s \cdot 100$ per magnitude. In declination, the personality does not appear till about magnitude 7·5; stars fainter than this are observed too far south. (M.N., November 1899.)

PHOTOGRAPHS OF NEBULÆ AT THE LICK OBSERVATORY. *J. E. Keeler.*—The Crossley reflector has been used this summer for photographing nebulæ, for which work Mount Hamilton presents almost ideal conditions, and the great reflector is found to greatly surpass refractors of equal aperture. Were the focal length greater, and the mounting better, even more remarkable results might be obtained. Experiments have been made to discover the best length of exposure to give and the amount of detail possible to obtain The best general picture of the small planetary nebula G.C. 4528 was secured in two minutes, the "ansæ" being well shown in ten. Exposures of one minute, 30 seconds, and 20 seconds, all gave well-defined views of G.C. 4964, a weak image with the central star just visible being produced in two seconds, and a bare trace of the nebula in one. It would be easy to greatly increase the number of known nebulæ with this instrument (16 new nebulæ were found on one plate $3\frac{1}{4} \times 4\frac{1}{4}$ ins.), but although a catalogue of those discovered by chance will in due time be published, attention will be chiefly directed towards gaining further information concerning those already known.

The ring nebula in Lyra has been repeatedly photographed with exposures varying from 30 seconds to two hours; 10 minutes gives the best picture. Examination of positives made on glass, enlarged about 11 diameters, proves that the ring is composed of a number of narrower rings interlacing somewhat irregularly, the interstices being filled with fainter nebulosity; there are also faint projections of nebulosity beyond the general outline, and their position angles and lengths have been measured. The banded appearance of the nebulosity within the ring which was shown in Lord Rosse's drawing, and has been generally regarded as fanciful, is now confirmed by the Crossley photographs; one of the dark bands is central, and their direction is at an angle of about 5° to that of the major axis of the main ellipse. Besides the central nucleus only one star (which is just visible at times in the 36-in. refractor) is seen in the inner space.

There is also a star (discovered by Dr. Holden) at the preceding extremity of the major axis, but others seen by various observers seem to be bright patches caused by the interlacing of the component rings.

The small nebula discovered in 1893 by Prof. Barnard near the ring nebula appears in the Crossley photographs as a left-handed two-branched spiral, with an extreme diameter of about 30 seconds.

Of the ring nebula in Cygnus (G.C. 4565) there exist two drawings, one by Sir John Herschel, showing a faint ring without detail, and one by Lord Rosse, showing also faint nebulosity within the ring. No other drawings or photographs appear to have been published. In the Crossley photographs this nebula is a nearly circular ring, with a fairly sharp outer boundary; inside the ring the brightness fades somewhat gradually towards the centre, which is marked by a star of about 16 m.; narrow streaks of nebulosity project from the inner edge towards the centre, like imperfect spokes. A star on the ring (observed by Lord Rosse) has probably no physical connexion with it. The positions of several small stars in the neighbourhood have been measured, with a view to discovering, at some future time, traces of proper motion in the nebula. (**A.S.P.**, October 1899.)

The Great Nebula in Andromeda. *H. C. Wilson.*—Two copies are given of a photograph taken with a three lens O.G. of 8 inches aperture, and a total exposure of 12 hours, on four nights. The patchy and broken character of the whorls is well shown, as are the lines of small stars along the spiral streams. The copies have been so treated as to intensify the fainter parts necessarily at the expense of the central detail. It is stated that the nucleus does not appear to be stellar upon the negative, though others with shorter exposures show a stellar point in the centre of the strongest nebulosity. The longest diameter in the engraving is about $1^{\circ}\cdot 7$, but another photograph, taken on the same nights with a 2·5-in. lens nearly doubles this. There are said to be indications upon two negatives that the small nebula to the N.W., H.V. 18, is right-hand spiral. (**P.A.**, December.)

Sextant Telescopes. *W. E. Plummer.*—The telescope usually supplied with a sextant has a power of from 10 to 14; the field is small and inverted, and the sextant has to be held so far from the body that, unless made of aluminium, it becomes burdensome. The result is that for observations at sea an ordinary Galilean opera-glass, with a power of three, or even a plain sight is frequently employed. Mr. Plummer has tried one of the prism opera-glasses made by Messrs. Goerz of Holborn Circus, and finds the field large enough, sufficiently well illuminated, and it is direct. A power of nine would probably be high enough for use at sea; for surveying 12 or 15 might be used with advantage. (**Nat.**, November 16.)

The Great Paris Telescope. *Sir Norman Lockyer.*—The O.G. is to have a focal length of 100 m. and a diameter of 1·25 m.; it is hoped that such a power may be used that the moon will be seen as if only 67 kilometres away from us, and that at this distance an object of 1 m. square may be seen (surely there is some

mistake here). The telescope is to be fixed in front of a siderostat with a plane mirror 2 m. in diameter and 0·3 m. thick. The glass for this was cast at the Jeumont glass works, and a description is given of the process of grinding and polishing. It required three months to adjust the slides which carry the rubber in order to ensure their parallelism with the plate, and the adjustment was verified every morning. Grinding was carried on generally between two and five in the afternoon, when the temperature does not change perceptibly, and it lasted for eight months, followed by two months polishing. The cell in which the mirror rests has a directing rod at its back attached to an equatorial motion, and it is supported on a vertical pillar capable of rotation about its own axis, the base of which rests in a cavity containing sufficient mercury to float nine-tenths of the total movable weight. A visual and a photographic object-glass are mounted on rails in front of the steel tube, so that either can easily be brought into use. The tube carrying the eye-piece is also mounted on rails and can carry a visual eye-piece, micrometer, photographic plate or projecting lens. In connexion with this last is a screen 20 m. square in a hall capable of holding 4,000 people. Images of the moon 16 m. in diameter, or of Mars 3·70 metres in diameter are to be projected on to this screen. The object-glasses were cast by M. Mantois, and they, as well as the mirror, have been figured by M. Gautier. (**Nat.**, December 21.)

PRESSURE IN THE SPARK. *J. F. Mohler.*—The amount of pressure produced when a spark is passed through a gas has been measured by Haschek and Mache, who give results for various media, different electrodes, and for variation of capacity when condensers are used, and variations of pressure in the surrounding media.

With a view to testing the correctness of their results J. F. Mohler has measured the shift produced in the spectrum lines using cadmium electrodes, this element giving the greatest shift for a given pressure.

If the results of Haschek and Mache are near the truth the shift of the lines should be considerable, as in many experiments they obtain pressures of more than 50 atmospheres.

The general results of Mohler's work does not confirm these high pressures. They show that pressure is produced when the spark passes through a medium, but that it is not nearly so great as supposed. They also show that the pressure varies with the density of the medium, and that the kind of gas does not affect the result. In a medium such as water, 800 times as dense as air, the lines of iron would be shifted about ·4 A.U., which nearly agrees with the results of Prof. Wilsing, who obtained a spectrum very similar to that of the new stars by passing a spark between electrodes immersed in water. (**Ap. J.**, October 1899.)

POSITION OF PERTH OBSERVATORY.—This has been determined by Mr. W. E. Cooke, with the co-operation of Sir Charles Todd, of the Adelaide Observatory. The latitude determined from meridian zenith distances of circumpolars is $31^\circ\ 57'\ 09''\cdot63$ S. The longitude found by interchange of clock signals with Adelaide is $7^h\ 43^m\ 21\cdot74^s$ E. (**Nat.**, Nov. 30.)

Variable Stars.

Confirmation of Variability.—M. Luizet, of the Lyons Observatory, confirms the variability of Sawyer's Algol type variable $+12^{\circ}3557$. He finds the duration of normal light to be $17^{h}\ 28^{m}$, the decrease occupies $1^{h}\ 58^{m}$, and the increase $1^{h}\ 55^{m}$. The variation is from about $7{\cdot}2^{m}$ to $7{\cdot}7^{m}$. (**P.A.**, 535.)

Maxima and Minima of Long Period Variables.

Star.	Maximum.		Minimum.		References.
	Date.	Mag.	Date.	Mag.	
T Canum Venat.	1898, Nov. 23	8·8	1899, Apr. 20	11·8	**A.J.,** 137.
T Cassiopeiæ	(m—m = 425d.)	—	„ Sept. 29	11·3	**E.M.,** 381.
V Cassiopeiæ	1899, Aug. 7	7·6	„ Apr. 16	12·4	**A.J.,** 138.
W Cassiopeiæ	—	—	„ May 17	12·1	„ 137.
RT Cygni	—	—	„ May 27	11·9	„ 137.
RZ Cygni	1899, Sept. 2	9·8	„ Apr. 15	12·8	„ 137.
ST Cygni	„ May 30	9·5	(M—M = 349d.)	—	„ 137.
T Draconis	„ Aug. 15	8·5	1899, Feb. 21	11·4	„ 137.
U Draconis	„ Sept. 4	9·3	„ Apr. 5	12·8	„ 137.
W Lyræ	„ June 4	8·0	„ Sept. 4	11·8	„ 137

Minima of the Variable Stars of the Algol Type.
(Given to the nearest hour G.M.T.)
(P.A., 535.)

U Cephei.

	d	h
Jan.	2	9
„	4	21
„	7	9
„	9	21
„	12	9
„	14	20
„	17	8
„	19	20
„	22	8
„	24	20
„	27	8
„	29	19

W Delphini.

	d	h
Jan.	15	8
„	29	18

Algol.

	d	h
Jan.	1	11
„	4	8
„	15	19
„	18	16
„	21	12
„	24	9
„	27	6

λ Tauri.

	d	h
Jan.	7	22
„	11	21
„	15	19
„	19	18
„	23	17
„	27	16
„	31	15

S Cancri.

	d	h
Jan.	8	8
„	17	20
„	27	7

R Canis Majoris.
Every 8th Min.
$P = 1^{d}\ 3^{h}{\cdot}3$

	d	h
Jan.	0	17
„	9	19
„	18	21
„	27	23

δ Libræ.

	d	h
Jan.	7	19
„	14	19
„	21	18
„	28	18

S Velorum.

	d	h
Jan.	7	2
„	13	1
„	18	23
„	24	22
„	30	20

U Coronæ.

	d	h
Jan.	1	18
„	8	15
„	19	0
„	25	22

DM $+45^{\circ}{\cdot}3062$.

	d	h
Dec.	0	6
„	13	23

SS Cygni.—Dates of maxima, &c., *T* representing the time of passing 9.35 m. on the rise.

Epoch.	*T.*	Max.	Mag.
7, short - -	1899, July 2·0	July 3·8	8·5
7, long - -	„ Aug. 23·0	Aug. 26·6	8·3
8, short - -	„ Oct. 25·0	Oct. 26·8	8·5

(A.J., 138.)

The principal features of the last maximum are :—

Previous normal period	44d.
Rise began	1899, Oct. 24·2.
Passed 9·35 m.	25·0
Maximum	26·8
Reached normal	Nov. 5·6
Above normal	12·4d

(P.A., 537).

Anderson's New Variables.—(i.) R.A., $21^h\ 14^m\ 7^s{\cdot}5$, Decl. $+13° 50' 17''$ (1855) has been followed through another complete period. A minimum at $12{\cdot}5^m$ occurred 1899, June 10, and a maximum at $9{\cdot}1^m$ September 18. The light-curve is regular. The interval between the two maxima is 205 days, and between the two minima 199 days. (A.J., 138).

(ii.) R.A., $17^h\ 55^m\ 24^s{\cdot}7$, Decl. $+19° 29' 20''$ (1900) was at $9{\cdot}0^m$ 1899, August 22 and 24, and by November 4 had declined to $12{\cdot}5^m$, thus showing that it is one of the comparatively rapid long-period variables.

(iii.) R.A., $20^h\ 11^m\ 32^s{\cdot}6$, Decl. $+30° 46' 1''$ shows a much slower variation. On October 12 it was at $9{\cdot}3^m$, November 8 at 9·7. (P.A., 537.)

Additions to the Library.

Turner.—Day numbers for 1900, 1901, 1902.

Turner.—The error of star photographs due to optical distortion. Curvature of star-trails.

Walker.—The Geographical position of Oxford University Observatory.

Turin Observatory.—Ephemerides of the Sun and Moon for 1900.

„ Meteorological Observations in 1898.

„ Hours of Sunshine, 1896–98.

Annuaire pour l'an 1900 (Bureau des Longitudes).

Connaissance des temps pour l'an 1901.

Vienna.—Kuffnerschen Sternwarte, Publicationen, 5 Band.

Strahan.—Total Solar Eclipse of January 22, 1898:—Reports from Indian Stations.

Barnard.—Micrometrical Measurements of Jupiter's Fifth Satellite, and on the Motion of the Line of Apsides of the Orbit of the Satellite.

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REPORT OF THE MEETING OF THE ASSOCIATION, HELD ON JANUARY 31, 1900, AT SION COLLEGE, VICTORIA EMBANKMENT.

W. H. MAW, F.R.A.S., *President*, in the Chair.

J. G. PETRIE, F.R.A.S. } *Secretaries.*
W. SCHOOLING, F.R.A.S. }

The *Secretary* read the Minutes of the last Ordinary Meeting, which were confirmed.

The names of eleven candidates for admission were read and passed for suspension, and the election by the Council of seven new Members was confirmed.

Mr. Holmes read a paper (p. 172) in which he first referred to the investigations of Prof. Schaeberle in regard to the defective definition of the Crossley 36-in. mirror.

Mr. Seabroke said he had not had an opportunity of reading Prof. Schaeberle's paper, and, therefore, hardly liked to say he differed from the gentleman, or that he was in any way wrong; but from what Mr. Holmes said, it appeared that to treat a mirror for the purpose in question as consisting of a number of small sections or parts of a mirror, was entirely wrong. The only proper method was to consider what took place when a wave of light fell upon the surface of the mirror as it existed. It did not do to treat the matter simply geometrically; it was not a matter of geometrical optics, but one which should be treated from the point of view of a wave falling on the surface, and Mr. Holmes had certainly taken quite the right view of the matter. It was obvious that the image did not lie in an infinite number of planes just as they divided up in their own minds the surface of a mirror; but it existed in probably one surface only, and as to what Mr. Holmes had said with reference to the sizes of the

several spurious disks, although he would not go so far as to say that, if they took a very small surface, the size of the spurious disks would be infinite, still it would be very large. If Mr. Holmes would consider those questions from the wave-theory point of view, perhaps he would on another occasion give them a further exposition of the matter.

Mr. Holmes, upon invitation by the President, said he could add something to what he had written. Prof. Schaeberle tested the 36-in. mirror, he relates, by having a disk made 34 ins. in diameter, with a 12-in. aperture in it. He placed the disk upon the mirror, and, having got the best focus he could, he found the 12-in. central aperture with 8-in. stopped out by the flat gave him only a fair image, and not a very good one. He examined the in-and-out focal planes with an eye-piece, and found he got a larger blurred image from the outer zone, and, on withdrawing the eye-piece, the image sprang into two rings, one larger than the other. This is what would be expected without any experiment at all, but Prof. Schaeberle appeared somewhat surprised at it. Then he found that the marginal 2-in. ring (though, if the mirror were 36 ins., and disk 34 ins., there would only be a 1-in. ring left, and even if the mirror were 37 ins., which he understood was originally the case, it would only leave $1\frac{1}{2}$-in. ring) gave an image many times less bright than the central ring, although he says the outer reflected more than twice the light of the central portion. But he further tells us that the tube cut off some of the rays from this marginal zone, and the flat allowed more of what he calls the injurious rays to pass by it, so that, taken also with the larger image formed, he thought the result just what might be expected. A narrow annulus could not give a neat disk. If we wish to understand how it acts, we have only to consider the diffraction effects of a narrow straight aperture. This makes a straight bright line with diffraction fringes on both sides. Now, conceive the straight line curved into a circle, and the result will be a bright ring with fringes inside and outside. Each annulus, in the experiment, made its own focal image, which images sprang apart on withdrawing the eye-piece as separate rings. The bad definition of the outer ring, taking the small tube and flat into consideration, would come from diffraction at the mouth of the tube acting as a stop, diffraction at the outer edge of the annulus, diffraction at the inner edge of the annulus, and diffraction at the edge of the flat, the result being a mass of diffraction fringes broken up by air currents, and not a disk at all, the central image, also the product of a narrow 2-in. ring, accounts for the merely fair disk that resulted from it.

Mr. Seabroke said Mr. Essam, of Billingborough, had sent him a drawing of Saturn, carefully executed, which was on the table for the inspection of Members. Unfortunately, Mr. Essam did not give the date on which he made the drawing—it would probably be in May or June last. Mr. Essam informed him he was able to trace Cassini's division just below the North Pole, and this remark, he says, corroborated Mr. Townsend's observations, which were, in short, to the effect that the fact of seeing Cassini's division where he saw it showed that the measures of

the diameters of the rings or globe of Saturn could not be exactly the measures of those diameters. Either the measures, or the inclination of the plane, or something or other was out, or Cassini's division could not have been seen in the place where he saw it. The drawing was made with a 12-in. Newtonian reflector. Mr. Essam desired his name to be added to the List of Members of the Saturn Section, and he (Mr. Seabroke) hoped other Members of the Association would follow his example.

Mr. Crommelin read some notes (p. 171) on the total solar eclipse of 1900, May 28, which were accompanied by two diagrams.

Mr. Maunder said that in 1896, when they were preparing to go to Norway, a number of papers were contributed to the "Journal" in the way of suggestions for observations that might be undertaken, and, thinking it would be found useful to follow a similar course in regard to the approaching eclipse, he had sought the co-operation of several of those who went to Norway in 1896, or India in 1898; viz., Miss Bacon, Mr. Johnston, Mr. Gare, and Dr. Downing (*see* p. 157).

Mr. Seabroke desired to ask Mr. Maunder the proportion of focal length to the aperture of the camera lens to which he had referred when he said the exposure might approximately be taken at one second for the corona. It occurred to his mind, while Mr. Maunder was speaking, that in 1870 Prof. Thorpe made some experiments during the eclipse on the change of general illumination; but in those days only sensitive paper was used—dry plates not then being known—and this was passed under circular apertures and exposed for a certain time.

Mr. Crommelin wished to ask Mr. Maunder how nearly he thought the screens to which he referred could be made to transmit a light of one colour only. He understood that the light of the corona was made up of two elements—one a continuous spectrum, and the other bright lines. Unless they could make their colour screen to transmit practically only one colour, the continuous part of the spectrum might get mixed up with the one colour they were trying to photograph, and might lead to confusion in the result.

The *President* said a good deal had been done in the way of getting monochromatic screens for microscopic work, and he thought some of the screens produced did admit light of a very limited range of wave-lengths, but, possibly, not confined to the part of the spectrum which Mr. Maunder desired to deal with.

Mr. W. H. Wesley said that he warmly endorsed Mr. Maunder's recommendation to those who drew to restrict themselves to small portions of the lower part of the corona. He had long urged upon those who proposed to make hand drawings, the uselessness of attempting to delineate the whole. The only further service that a draughtsman could render had been in drawing the extreme extensions of the corona, but since the remarkable photographs that Mrs. Maunder took during the eclipse of 1898, it seemed

evident that photography would do that perfectly. Those who make hand drawings should therefore take some portion of the corona near the limb. We shall not advance in building up the corona from the projection of it seen during an eclipse without an exhaustive study of the lower coronal rays.

In reply to Mr. Holmes, who asked what would be the probable temperature at Algiers at the time of the eclipse, *Mr. Crommelin* said a guide-book he had consulted stated that the temperature varied very little throughout the year. It was 14° C. in January, and 24° in August, which was a range of 10° C. or 18° Fahr. during the whole year. The mean between January and August would be 19° C., or about 66° Fahr.

Mr. Downing.—That does not represent the temperature at three o'clock in the afternoon.

Mr. Crommelin.—No; that is the mean of the day. (Another guide book gives 69° Fahr. as the mean temperature in May).

The *President*, referring to what Mr. Maunder had stated as to the use of a screen, said that if Mr. Maunder could determine a range of wave-lengths that he thought would be useful, and would give particulars of it at the next meeting, some of the members who had been paying particular attention to the construction of screens for monochromatic work would very possibly go into the matter, and probably they might be able to evolve a standard screen suitable for employment in the way Mr. Maunder had suggested. It would be very desirable not only that a screen of approximately the true colour should be used, but that all screens should be very closely alike. Mr. E. M. Nelson and Mr. Curties had made a great many experiments on the production of a standard screen for microscopic work, and probably they would aid in the matter if asked.

Mr. J. J. Vezey said that Mr. Giffard, of Chard, had devoted great attention to this subject, and had been very successful in producing screens for transmitting monochromatic light.

Mr. Maunder said, with regard to Mr. Seabroke's question as to the relation of aperture to focal length, he had in his mind such a ratio as 1 to 15 or 1 to 16. Of course, if the aperture were relatively greater to the focal length, the exposure might be shorter. With regard to the question of the screens, his notion was that one might work in two directions—one by limiting the sensitiveness of the plate, and the other by limiting the quality of light transmitted by the screen. He thought the combination would give them greater control of the exposure than the one alone would. Practically, the hydrogen line, in his opinion, would be far easier to compass than the coronium line. He ought to have mentioned amongst the eclipse suggestions the drawing of the corona with the naked eye, which was carried out so successfully in India in 1898; but he was more impressed to lay stress on the drawing of the corona at the telescope, because it had been so entirely neglected on former occasions, and he would be glad to see it restored to a place in regular eclipse

observations. With reference to the proposed expedition to view the eclipse, the committee had made a provisional arrangement with the Royal Mail Steamship Company for the conveyance of the party by one of their finest vessels, the "Tagus"; but at present the number of Members who had actually engaged their berths and paid their deposits was only about half that required to make the expedition a success. He hoped, therefore, Members who were thinking of doing so would send in their names and their deposits without further delay; otherwise, the proposed expedition would have to be abandoned. The Association, of course, could not enter upon a speculation in the matter, and as they were not providing for making any profit in the matter, they could not take any definite step until they were perfectly certain of such an amount of support as would insure the Association against the risk of loss. The Royal Mail Company had extended the time for signing the contract to February 12. If by that date a sufficient number of passengers had actually engaged their berths, the steamer would be secured. If not, the idea of engaging a steamer must be entirely abandoned. He (the speaker) felt sure that if this was the case, a good number who were now holding back would, when they found how difficult it was to make satisfactory arrangements, regret exceedingly that they had let so good a chance fall through.

The *President* said it would be a very serious thing for the Association if the proposed expedition were to fall through, and he hoped Members would do their best to get their friends to make up their minds immediately, and communicate with Mr. Maunder on the subject. The support the committee had received up to the present time was only about half large enough. The matter had been thrown back a good deal by the war in S. Africa, which had affected a great many people, and had been the means of crippling the Irish expedition, which was to have been organised on the same lines as that of this Association. The Royal Dublin Society, the Royal Irish Academy, and two other societies had expected to send out an expedition of 140 members; but this number had dwindled down to six, who intended, under the circumstances, to take part in this Association's expedition. They had themselves been affected in the same way, and although things did not look very rosy at present, he hoped they might yet organise a successful expedition.

Dr. Downing read a paper on "Where the Day Changes" (p. 176).

Mr. Crommelin remarked that Dr. Downing's very interesting paper cleared up in a most lucid manner a question one was often asked. It had hitherto been difficult to give a very definite answer to the question, but they could now simply point out the exact place where the day began. It was rather a curious anomaly that for 24 hours a portion of the earth would be in one century and another portion in another. He might even go so far as to say for 36 hours, for there were two different methods of reckoning the beginning of the day, the civil day commencing at midnight and the astronomical day at noon, so that at Greenwich they were accustomed to using the date of the old year until noon

on January 1. There would thus be 12 hours when for one purpose one would be in the 19th century and for another in the 20th century, and if they extended that right round the world and added the 12 hours to the 24 hours' rotation, it would make 36 hours of ambiguity.

Mr. Kennedy asked whether it was not perfectly true that the birth of Christ was three years B.C.? If so, that rather added to the difficulty. They had also to take into consideration the Old Style, in which there was a difference of 13 days as compared to present-day reckoning; so that, quite apart from the three years, the 19th century would go on for another 13 days if they took the Old Style into account.

A Member remarked that in the East they did not hold to December 25 as the date of Christ's birth. He had been told by missionaries that it was reckoned to be somewhere near March.

Dr. Downing agreed with Mr. Kennedy that it was quite probable the reckoning of Dionysius was three, or even five, years wrong; it depends on the identification of the great census, mentioned by St. Luke; but that, he submitted, did not affect the question at all. The first year of our era was called A.D. 1, and we still called that year A.D. 1, and counted on from it. Neither did it matter, in this connexion, whether Our Lord was born on December 25 or not. He (the speaker) did not hold to that himself—but it did not affect the question at all. The point was that Dionysius decided that the birth of Christ took place on December 25, B.C. 1, and therefore the Christian era was to commence from the following January 1.

Mr. Goodacre read a paper by Mr. C. F. Smith on "The "Palus Nebularum Region of the Moon" (p. 150).

Mr. Goodacre said that in the main he was rather inclined to agree with what Mr. Smith said as to the chronology of the various formations. He had some doubt, however, as to whether Mr. Smith's theory to account for the radiating ridges was one which could be altogether accepted. It appeared to him that they were not ridges of lava which had overflowed from the rim of the crater, for, as far as his own observation went, there was no appearance of cracks or gullies in the walls which would form apertures through which the lava would flow. This was a phenomenon which was accounted for by the sudden upheaval of the mountain ring itself.

Two slides were then thrown on the sheet which had been prepared from instantaneous photographs of a boiling mud crater in the N. island of New Zealand, within 20 miles of the well-known volcano whose eruption some time ago destroyed the beautiful terraces of pink and white. As Mr. Goodacre remarked, these slides showed details very similar in appearance to what was seen on the moon, and the study of terrestrial features of this nature might throw a considerable amount of light on the way in which the lunar craters had been formed.

Mr. Hardy asked if it would not be possible to arrive at a mean level of the moon's surface which could be used as a datum line in calculating the heights and depths. At present some lunar formations were described as being 7,000 feet high, and other parts 10,000 feet deep, but no standard level was assumed. If such an accepted datum level was taken—and it did not appear to be impossible—they would be able to speak of the heights of the mountains above that surface and the depths of the hollows below it.

Mr. Crommelin said there would be great difficulty in ascertaining the difference of level between two distant plains on the moon. There was on the moon no liquid surface to give a uniform standard of measurement as we had on the earth. They could only measure heights by the shadows, and where the surface had so slight a slope as to throw no shadow he did not see how they were to get the relative heights of two flat regions some distance from each other. The only way in which to do this would be to take advantage of the libration of the moon and take two photographs at extreme libration, and compare the forms in one and two. Some result might be obtained by that means; but it would be a laborious and difficult task.

Mr. S. A. Saunder said that our knowledge of lunar altitudes was very insufficient—we did not know the heights of the mountains within 20 or 30 per cent. If anyone would open Schmidt's book at random, and take any mountain he had measured ten or a dozen times, it might be found that its greatest height was double its smallest. It would very frequently be 50 per cent. greater, so that there was little or no possibility of their getting any accurate measures of levels as yet, and he thought it would be exceedingly difficult to compare the level of one plane with the level of a distant plane. Dr. Weinek, a short time ago, published a pamphlet in which he described how he found the height of Pico by measurements made on photographs, deducing the sun's altitude from Mädler's position of Pico by computation. He measured it on three or four photographs, and obtained very consistent results, very much more consistent than those obtained by Schmidt. As the position of the mountains of the moon became known more accurately, so that the altitude of the sun could be computed, they would have a very good chance of arriving at the height of the mountains. He doubted whether Mr. Smith was accurate in saying that MM. Loewy and Puiseux placed the date of the formation of such craters as Autolycus and Aristillus previous to the formation of the seas. His own idea was that they placed the date later. MM. Loewy and Puiseux divided the history of the formation of the lunar surface into five periods, and he was almost certain that Copernicus, which was a mountain much like Aristillus, was placed in the last period as having been formed after the plain. They said some of the ringed mountains were formed in an early period, and some after the large plains, and that the formations in the latter period could be distinguished by the regularity of their walls, and by their isolated position.

The Meeting adjourned at 7 p.m.

Reports of the Branches.

NORTH-WESTERN BRANCH (MANCHESTER).

The Third Meeting of the Session was held on December 6, when, in the absence of the President through indisposition, the chair was occupied by Mr. S. Okell, F.R.A.S. There was a good attendance of Members.

The preliminary business, including the election of one new Member, having been disposed of, a portion of the evening was devoted to the recounting by Members of their experiences in the observation of the Leonid meteors, either individually or as connected with organised parties. Reports from distant Members on the same subject were likewise presented. The account of the adventurous balloon voyage of the Rev. J. M. and Miss G. Bacon in order to observe the meteors from above the denser atmosphere of the ordinary spectator was also read by Mr. Okell, together with letters afterwards received from the balloonists, and as Miss Bacon had so lately been amongst us, having delivered the opening lecture of the Session, Members were naturally much interested in the account.

Mr. A. Stanley Williams' paper on the double canals of Mars was also read, and formed a subject of subsequent comment.

WEST OF SCOTLAND (GLASGOW).

The Fourth Meeting of the Sixth Session of this Branch was held on Friday evening 19th January, the President, Rev. Edward Bruce Kirk, occupied the chair, and there was a large attendance. The election of two new Members and eight Associate Members was declared, and one new Member and four Associate Members were nominated for election. Notes on the constellations visible in the southern meridian during January were read, including Canis Major, Canis Minor, Gemini, Auriga, and Cancer; special reference being made to the Sirian and Procyon systems, the more interesting double stars and clusters in each asterism (especially the cluster Messier 35 in Gemini), and the Nova Aurigæ of 1892, illustrated by a series of lantern slides prepared from Cottam's charts, Dunkin's "Midnight Sky," &c. Major Cassells also submitted a series of recent sun-spot views, taken from photographs, which were briefly explained by Mr. John Main, F.G.S., the secretary. These views depicted the changes in contour and general appearance which the spots undergo during their period of transit across the solar disk, especially in the perspective of the umbra and penumbra, as seen at different stages of the transit, and were very interesting exhibits of solar phenomena and energy. Before the lecture of the evening was given the President intimated that plans of the ship engaged for the expedition to observe the coming solar eclipse had been received from the parent Association, and could be inspected by Members and friends desirous of securing a berth. The Rev. Hately P. Waddell, F.R.A.S., Member of the East of Scotland Branch of the Association, then delivered a lecture on "Some

Moon Drawings and Photographs," embodying a record of the lecturer's own selenographical work. Several finely executed drawings of the leading lunar craters and ring-plains were shown and described by him, including Petavius, Gassendi, Ptolemy, Plato, and Copernicus. The drawings were specimens of accurate delineation, appearing to stand out in relief on the screen, and revealing all details visible in large apertures, and to eyes educated to the proper study and grasp of lunar details. The lecturer, in passing, expressed his disapproval of the practice of retouching photographs in the manner so commonly done now, which only resulted in producing something of a nondescript nature, being half photograph, half drawing. Mounted photographs of the moon's surface, taken by the lecturer at various phases of lunation, were handed round the audience for inspection; and, being beautifully taken photographs, were much admired for their crispness and general finish. Mr. Waddell interspersed his lecture with useful advice and hints on the drawing and photographing of the moon's surface, and briefly referred to the fascinating scenery which that orb displayed, as revealed by the telescope and camera. On the motion of the chairman a cordial vote of thanks was awarded to the lecturer.

EAST OF SCOTLAND BRANCH.

The fourth Meeting of this Branch for the current session, was held at No. 5, St. Andrew Square, Edinburgh, on the evening of 20th January, the President in the Chair.

A paper on "The Rise and Fall of Astrology" was read by the Rev. D. R. Fotheringham, M.A. Mr. Fotheringham gave much interesting information regarding the origin of astrology, showing how the various celestial phenomena would differently affect the farmer, the sailor, the shepherd, &c. He pointed out that the history of astrology and the history of astronomy were one and the same from the earliest records down to a comparatively recent period. Mr. Fotheringham also showed that the methods adopted even by present day astrologers were very inaccurate, and gave one or two amusing instances of his own attempts at forecasting. After some discussion, the thanks of the Meeting were accorded to the speaker for his most interesting paper.

A short discussion upon the recent lunar eclipse followed, and Mr. C. F. Smith afterwards showed an oil painting of the Palus Nebularum region of the moon, along with the drawings from which the painting had been made.

One new Member and two associates of the Branch were elected.

VICTORIA BRANCH (MELBOURNE).

The last Meeting of this Branch during the present year was held on 2nd November 1899, Mr. C. E. Oliver, M.C.E., in the chair.

Mr. P. Baracchi, F.R.A.S., requested Members to be prepared to observe on the early mornings of the 15th, 16th, and 17th November the expected shower of Leonid meteors, and gave Members by circular full instructions for methodical observation,

Mr. David Ross having returned from a visit to the Old World, gave his fellow Members an interesting account of his travels, referring more particularly to his visits to the Cape, Greenwich, Edinburgh, Mount Hamilton, Windsor, and other observatories.

Several lantern slides of many interesting places which Mr. Ross had visited were exhibited on the screen, and for a while his hearers were, in a measure, enabled to share in the pleasures of an excursion enjoyed by a few, but desired by all.

Papers communicated to the Association.

The Palus Nebularum Region of the Moon.

By C. F. Smith.

Selenology has now reached a stage, thanks to the wide awakening of interest which has taken place within the last few years, when it may fairly be claimed that the features presented by many regions on the moon's surface can be interpreted with at any rate probable accuracy. In this paper an attempt will be

made, in the light of recent views regarding the origin of lunar surface features, to explain some of the formations of the Palus Nebularum; and in explaining these, many similar regions in different portions of the surface will, as it were, be dealt with.

The accompanying illustration of this region is taken from an oil painting in monochrome, copied from pastel drawings made during the spring of last year. The instrument employed was a $5\frac{1}{4}$ in. Calver reflector, powers 100 to 300. As far as detail goes, the region is better represented than it would be by a photograph, as all but the most minute features are included. Numerous very small crater-pits and hillocks and a few delicate rills are omitted, being beyond the range of the instrument employed, and, of course, much would be missed through unsteady air, and inadvertence. But such omissions will not in any way affect the general accuracy, or the conclusions to be drawn from our consideration of the region.

The formation which primarily claims our attention is the walled-plain Archimedes, and it does so in virtue of its vast size, its symmetrical outline, and the great height of its encircling rampart. Its diameter is about 50 miles, and the average height of the wall about 4,000 ft., while a peak upon the S.E. border rises to 7,000 ft. The outer wall exhibits terracing and considerable irregularity of contour, but it will be noted that the slope abruptly joins the surface of the adjoining *mare* and forms a strong contrast in colour and ruggedness to the surrounding sea. We are at once forced to the conclusion that Archimedes was formed before the Palus Nebularum, and, further, that the material forming the latter was once in a liquid or viscid condition. This latter conclusion is further borne out when we examine the foot of the N.W. glacis. Here a deep gulley irregularly encircling the foot of the wall is to be seen, and its appearance strongly suggests its being the edge of a once viscous sheet of molten material. To the south of Archimedes is seen one of the well-known rills in this region, lying, in accordance with the rule followed by the majority of rill-systems, on the border of the sea. This curious arrangement is probably due, as MM. Lœwy and Puiseux point out, to the cooling and consequent shrinkage of the material forming the sea.

The pair of ring-plains—Autolycus and Aristillus—lying to the E. and N.E. respectively of Archimedes, is one of a number of similar pairs in this quadrant, such as Atlas and Hercules, Godin and Agrippa, Eudoxus and Aristoteles, and others less prominent. The fact that craters so often lie in isolated pairs in many parts of the surface is much easier to state than to explain. It will be noticed, however, that in most examples of pairs, one crater is considerably smaller than the other, and it may be suggested that, after the completion and solidification of the larger one, the same series of local disturbances resulted in the smaller. While Archimedes has the smooth and almost featureless floor common to the larger walled-plains, the greater proclivity to central mountains on the part of ring-plains is evidenced by the smaller pair. But, at the same time, it is by no means impossible that a buried central mountain may exist within the walls of Archimedes, completely hidden by the material

which has undoubtedly welled up or flowed in since the completion of the wall. Both Autolycus and Aristillus, but especially the latter, show ridges radiating from their outer walls, which, coarse at their starting point, gradually fine away to invisibility, some of them being followed to a distance of above 50 miles. Such radiating ridges are also finely exemplified in Copernicus, from which they can be traced in some cases to nearly 100 miles. There is, of course, no doubt that such ridges are the result of disturbances within the crater, and it is probable that they represent molten matter which has flowed from within the walls through cracks and gullies. At the same time, it is a curious point that the floor of the crater—from which we must assume the ridges to have flowed—is lower than the slopes from which these start. The obvious conclusion, however, is that the floor, when liquid or molten, had a changing level, and at one or more times reached the level of the ridges at their sources, finally sinking to and hardening at its present level. The probability of such a conclusion, too, is supported by considerable evidence from other regions of the moon's surface of once fluctuating levels in the floors of craters. While, in the case of Archimedes, it is comparatively easy to see that the surrounding *mare* was formed after the crater, the relative chronology is more difficult to ascertain with regard to Autolycus and Aristillus. In the first place, the craters are smaller, and the exterior slopes exhibit less detail; while, in the second, the lower portions of their places are entirely masked by the corrugations of the radiating ridges. I have, however, in a former paper* pointed out some characteristic differences between craters formed before and after the seas on which they now stand, and there is little doubt that from their size, and the nature of the details they exhibit, that the pair under consideration were formed before the Palus Nebularum. Now, if we are right in concluding that the craters were formed before the sea (and such a conclusion is entirely confirmed by the recent publications of MM. Lœwy and Puiseux), a very interesting and important point follows. We saw above that the ridges radiating over the plain in all probability emanated from the interior of the crater, and yet the crater was formed before the plain. The two statements are incompatible, except under the assumption that while the walls of the crater were formed before the surrounding sea, the *floor* was formed *after*. Such an assumption, however, is quite a legitimate one, being confirmed, though not to a large extent, by similar features elsewhere.

To the N. of Archimedes, beyond the arc of bright mountains upon the terminator, lies a good example of a "ruined" crater, the walls showing only as undulating ridges close to the terminator. This originally has been a crater formed in the same epoch as Archimedes, but the country upon which it stood has sunk to a greater extent, and in consequence the crater became almost completely submerged by the irresistible flow of the liquid Palus. Its central peak apparently still survives, and the difference between its comparatively dull slopes and the brilliant peak of Piton to the N. eloquently bespeaks its greater age. Piton, rising loftily (7,000 feet), brilliantly, and abruptly from the

* Vol. IX., No. 7.

level of the sea. is probably what Nasmyth terms a "mountain of exudation," and it is unlikely that its base penetrates below the level. At the same time it must be pointed out that the central mountain of the ruined ring-plain should not be so apparent as it is, in accordance with the rule that the central mountain of a crater never overtops its walls. We can hardly consider this case to be an exception, and it may simply be a coincidence that a newer mountain mass is found situated upon—or rather above—the site of an older one.

To the W. and S. of the Palus lie the Caucasus and Alps, both only shown in part in the illustration. Among the older selenologists there is an assuring consensus of opinion that the principal mountain ranges on the moon are amongst the earliest formations, and this view has been entirely confirmed by the recent researches of MM. Loewy and Puiseux, aided by their admirable photographs. Indeed, it may be said that this is one of the most surely established facts elicited by the study of lunar topography, and confirmation is to be found on all parts of the moon's surface.

Cassini, curiously missed by Hevelius and Riccioli, is a formation of more than ordinary interest, and forms a fine telescopic object when viewed under suitable illumination and sufficient magnifying power. Its shape is very distinctly polygonal, while the outer slopes of its walls exhibit an abnormal amount of detail, and cover a large area of surface. The interior, which contains two fine craters and a curious digitated group of hills, is said to be almost, if not quite, at the same level as the surrounding *mare*. The wall at its southern part gradually declines in height—in much the same manner as the southern wall of Gassendi—until it apparently reaches the level of the sea, and for a short space is entirely absent. Here the material of the *mare* has probably flowed through into the crater, but—Cassini being on the boundary of an area of depression—the work of destruction has proceeded no further, the floor and exterior surface hardening at their present level. The sharpness of contrast between the glaces at their bases and the surrounding plain proves, as in the case of Archimedes, the earlier formation of the crater.

The small ring-plain Theaetetus, lying to the S.W. of Cassini, close to the steep eastern slopes of the Caucasus, has, on the other hand, been formed after the viscid flood which came so close to wrecking the larger formation. Its small size, coupled with its completeness and entirety of form, the want of detail upon its outer slopes, the brilliance of its inner walls, all suggest that no depleting inundation has ever affected it, but rather show that it has been formed after the completion of that *mare*.

From our detailed consideration of its various features, what, then, is the probable history of the Palus Nebularum? In the first place, this part of the moon's surface was at one time completely covered with mountains and crater-formations, the latter of a size not less than Theaetetus. In course of time, a large area became depressed (probably through contraction of the cooling interior), and liquid material welled up through cracks and rents in the surface. This gradually spread, covering many formations entirely, almost wrecking Cassini, and reaching the northern and western walls of Archimedes in a viscid state, but ceasing to rise before breaking down the massive ramparts of that crater.

Although upheavals and elevations on the most gigantic scale were now at an end, internal activity continued to manifest itself in the formation of the craters Theaetetus, Kirch, Piazzi Smyth, and the numerous smaller openings freckling the surface of the *mare*. The interiors of Autolycus and Aristillus filled with liquid which flowed through the cracks and gorges in their walls, and spread in radiating streams far over the surrounding plain, while, again, the form taken by the escaping fluid was that of an "exudation cone," which gradually and quietly built itself up. To put in concise form the fourth order of formation, we have—

(1.) The Caucasus and Alps.
(2.) The craters Archimedes, Autolycus, Aristillus, Cassini, and others now buried
(3.) The dark plain of the Palus.
(4.) The craters Theaetetus, Kirch, and Piazzi Smyth.
(5.) The mountain mass Piton.
(6.) The minute craters on the surface of the *mare* and elsewhere.

The most doubtful "date" is that of Piton, which may possibly be a protruding peak from an early mountain range, but, on the whole, it is more probable that it was formed after the sea.

Report of the Rousdon Observatory, East Devon.

Observations of Long Period Variable Stars during the Year 1899.

By Sir Cuthbert E. Peek, Bart., M.A., F.R.A.S.

C. Grover, *Assistant.*

With the exception of November (which was an abnormally cloudy month) the year has been generally favourable for astronomical work and observations have been made on 167 nights. The number of magnitude determinations has been 570. During the 14 years this work has been in progress 6,248 magnitude determinations have been made, Argelander's method being followed. Each observation consists of the mean of five visual comparisons of the variable with stars whose magnitudes have been determined by either by myself or by some other observer, and all comparisons are made with stars in the same field of view as the variable. Thus, during 1899, no less than 3,420 estimations of stellar brightness have been made. At the commencement of this research in 1886, the selection and observations of suitable comparison stars involved much labour, but of late years the lists of comparison stars with their photometric magnitudes, as furnished by the Harvard College Observatory, have been employed, and all the earlier observations have been examined and reduced to the same scale, thus the observations, as published in the "Variable Star Notes," are all founded on the Harvard magnitudes.

The instrument used throughout has been a 6·4-in. equatorial refractor, by Merz, the powers generally used being 34·80 and 132. A 13·5 magnitude star is the limit of vision.

About 30 long period variables are systematically followed, and as most of these are circumpolar in this latitude their light

variations are continuously recorded. During the progress of the observations 245 maxima and 214 minima have been observed. The following table gives the particulars of those observed during 1899:—

Star.	Maxima.	Mag.	Minima.	Mag.
T Cassiopeiæ	April 17	7·3	Sept. 29	11·3
S Cassiopeiæ	—	—	June 15	12·7
S Persei	—	—	Dec. 4	10·0
R Aurigæ	April 17	6·9	—	—
U Orionis	April 15	6·0	Nov. 26	11·8
R Lyncis	August 9	6·5	Jan. 16	13·5
R Ursæ Majoris	August 12	7·6	March 4	13·1
T Ursæ Majoris	July 3	6·3	March 15	12·6
" "	—	—	Nov. 15	13·0
S Ursæ Majoris	July 20	7·5	April 7	11·6
" "	—	—	Oct. 30	12·2
S Bootis	July 3	8·3	Feb. 1	13·0
"	—	—	Nov. 20	13·0
R Camelopardi	May 2	8·0	Jan. 6	<13·0
"	—	—	Sept. 26	13·6
R Ursæ Minoris	—	—	Sept. 26	10·4
R Draconis	June 18	7·6	Feb. 27	11·9
			Nov. 26	13·3
S Herculis	Sept. 21	6·4	—	—
T Draconis	August 16	8·0	Feb. 28	12·1
R Cygni	Feb. 19	7·3	—	—
χ Cygni	May 22	3·6	1898. Dec. 20	12·6
"	—	—	1899. Nov. 26	12·0
S Cygni	March 4	10·2	—	—
T Cephei	1898. Dec. 28	5·6	June 3	9·5
S Cephei	—	—	May 2	12·6
R Cassiopeiæ	June 3	5·8	—	—

It will be noticed that during the year 17 maxima and 22 minima have occurred, and as most of these stars at minimum fall to between 12·0 and 13·0 magnitude, and several much lower than this, the observations have been correspondingly difficult.

It must be understood that in consequence of the flatness of many of the curves at maximum and minimum, these dates are only approximate.

Remarks.

T Cassiopeiæ.—The light curve has been very irregular. Observations of this star commenced at the end of 1888. Since then eight maxima and eight minima have been observed. The light at maximum has ranged from 6·6 magnitude in 1890 to 7·3 magnitude tn 1899. At minimum it has ranged from 10·6 to 12·7 magnitude.

S Cassiopeiæ.—Varied but little from 12·5 magnitude during the 10 months January to October. A rapid rise then set in, and the star varied from 13·0 magnitude, October 25, to 8·7 magnitude, December 27.

S Persei.—Gradually declined during the latter half of 1899, and on December 4 was 10·0 magnitude. In April, May, and June the light was steady at 8·3 magnitude. The changes are very slow, and the extreme range during the last 10 years' observations has been about three magnitudes.

T Aurigæ.—A very faint and small nebula occupies the place of this star. Just seen with power 132.

U Orionis.—The interval between the minima, November 18, 1898, and November 26, 1899, was 373 days, and the interval from the maxima, 1898, April 5, and 1899, April 15, was 375 days. This is a near approach to the mean period of this star.

R Lyncis.—This was the brightest maximum since 1893. The mean interval of the last six maxima has been 375 days. At minimum the star falls very near to the limit of vision with the Rousdon telescope.

R Ursæ Majoris.—The minimum was very faint and prolonged, the star remaining below 12·0 magnitude for four months. At about maximum the light curve was very irregular, rising one magnitude in six days.

T Ursæ Majoris.—The interval between the last two maxima was 267 days, and between the last two minima 247 days. The mean (257 days) being the reputed period of the star. At about the minimum it remains below 12·0 magnitude for about two months, and is a very faint and difficult object.

S Ursæ Majoris.—The light curve has been very irregular. The interval between the last two maxima was 256, and between the last two minima 206 days. The rise is generally much more rapid than the decline.

S Bootis.—Twelve maxima and 12 minima have been observed since 1890. The maximum magnitude is about 8·5, and the minimum about 13·0. The interval between the two minima observed this year is 292 days, and between the last two maxima 283 days.

R Ursæ Minoris has of late been unusually faint, and was 10·4 magnitude on September 26. This is the faintest record since observations of this star began in November 1891. The entire light range is less than two magnitudes.

R Draconis.—The minimum, February 27, was the brightest observed since 1891. At the next minimum, November 26, it fell to 13·3 magnitude, and was near the limit of vision of this telescope. The interval was 272 days.

S Herculis.—This was the brightest maximum of the last 10 years.

T Draconis.—Four maxima have been observed since observations began in May 1895. The mean period being 424 days. The range is from 7·5 to 12·1 magnitude.

χ *Cygni.*—This was the brightest maximum recorded since observations commenced in 1886, and the variable was distinctly visible to the naked eye even in strong moonlight. The interval since the previous maximum was 405 days, which almost exactly coincided with the reputed period.

R Cygni during September fell below 13·0 magnitude, and became invisible with this telescope, but a very faint nebula is sometimes seen in the place of the variable.

S Cygni.—The maximum in March was the faintest observed since observation of this star commenced in 1892. Eight maxima have now been observed, the mean interval being 325 days, which is very near the reputed period of this star.

S Cephei.—The interval between the minimum here given and the previous minimum, 1897, December 24, is the long period of 494 days. The light curve is very irregular, and the magnitude at various maxima and minima varies greatly.

R Cassiopeiæ.—The interval between the maximum here given and the previous maximum, 1898, March 14, is 446 days. At the end of the year the star was again about minimum magnitude.

Abridged notes of these observations have appeared monthly in the "English Mechanic."

"Variable Star Notes," No. 4, containing observations of R and χ Cygni for the 10 years 1887 to 1896, and "Variable Star Notes," No. 5, containing observations of U Orionis and S Herculis for the 13 years, 1886–1898, have been published and distributed. The results are given concisely in tabular form accompanied by diagrams of the light curves. Further instalments of the work are in hand.

Transits of stars have been taken as often as required, for the rating of the siderial clock.

Eclipse Suggestions.

By E. Walter Maunder, F.R.A.S.

It is hoped that the approaching eclipse of the sun, occurring as it does in a country at no great distance from our own shores, will attract a very large number of persons to watch it. Of these, many, no doubt, will go simply to see an unusual spectacle, but it is to be hoped that many will also wish to do something which in one direction or another may tend to forward the interests of science.

It goes without saying that the best work may be expected from those who are in the constant practice of observing, and especially those who are accustomed to work on the same lines as are found most efficient in eclipse work. But the duration of an eclipse is so short, and the problems it offers are so numerous, that it would be a grievous pity that any possible observing force should be allowed to run to waste; and a little organisation and division of labour may easily secure a good deal of useful work,

even from inexperienced observers. A striking illustration of what can be accomplished in this way was afforded by Sir Norman Lockyer at Viziadrug in 1898. Here, beside the actual members of the party which he took out with him, he had some 170 volunteers, mostly officers and men from H.M.S. "Melpomene." These were so admirably organised under Sir Norman Lockyer's direction by Mr. Fowler,* and were so well trained by him, that though the very great majority must have been entire novices to astronomical work, a most gratifying standard of efficiency was obtained. We may be perfectly sure, therefore, that with like training and division of labour results certainly not less satisfactory may be obtained by ladies and gentlemen whose interest in astronomy is real, and many of whom have had more or less experience in some classes of practical observation.

Necessarily, hints for the assistance of observers of this class must assume that they have few, if any, instruments, and those of a simple character. It may be assumed that the possessors of large, costly, or complicated instruments have already made their own arrangements for carrying out the researches for which their instruments are adapted, and that, consequently, any hints or suggestions are only required in the case of those with small instruments, or with none at all.

Small Telescopes.

By this term it is intended to indicate an achromatic of from 2 to 4 ins. aperture, mounted upon a portable tripod stand of the ordinary type.

If, as we may hope, a considerable number of such instruments are taken out to the eclipse, then one at least at each station should be devoted to watching the progress of the partial phase in order to give the precise time of 2nd contact to the other members of the party. The observer can do more than this. He can give a double warning of the approach of the critical moment. Probably the simplest method of effecting this would be to observe the sun during partial eclipse by projection, a white screen being arranged behind the eye-piece of the telescope. On this a circle should be drawn which the sun should be made exactly to fit, and a scale of degrees should be marked round the limb, or at any rate arcs of 90° and 45° should be clearly denoted. The sun should be kept with its limb coinciding with the circumference of the circle as the eclipse goes on, and the observer should call out directly the lessening arc of sunlight is reduced to 90°, and again when it is reduced to 45°. The time before second contact of these observations can be computed previously for each station. An amanuensis should attend the observer with a chronometer to note the time which he gives.

This preliminary work over, distinctly the most important observation which the worker with such a telescope could make is the drawing with a moderately high power of the structure of the corona in some one small and definite region. He should perfectly prepare himself from the first to entirely leave on one

* To whom I am indebted for several suggestions in the following paper.

side any idea of a general delineation of the whole corona. The attempt to do so would be doomed to failure, and if any sketch were made it would be perfectly valueless. The observer should have fully made up his mind before the eclipse as to the region in which he proposes to work. The regions most likely to be fruitful are (1) round either of the solar poles, (2) in the neighbourhood of a bright prominence, (3) at the root of some principal coronal streamer.

In the first case, a field of about 30′ or somewhat less would probably correspond to the most suitable power. The point to which attention should be drawn is the intimate structure of one or two of the polar rays and their relationship to each other, particularly whether they seem to be in the same plane, and whether they rise from the pole itself or from a considerable distance from it. Their deviation from a strictly radical line should also be carefully noted; also the particular degree and character of any curvature which they may show. Again, it cannot be too greatly impressed upon the observer that to thoroughly examine the structure of one or at most two rays will be far more valuable than any attempts to cover a wider area.

(2.) If a prominence is selected as the centre of observation a higher power may be used than in the former case. Here the observer may neglect any close attention to the detail of the prominence itself, except and so far as its structure appears to show connexion with that of the corona in its immediate neighbourhood. It is such connexion which is the important matter to bring out here. Many photographs in recent years have suggested strongly that the coronal forms appear to be repelled to a certain distance from the prominences, or at any rate, to curve themselves round the latter at a considerable distance from them.

(3.) In default of any sufficiently large *red* prominence it would be of interest to study as carefully as possible any really bright *white* prominence that might show itself. Here, again, a single object is the utmost that should be attempted. Failing either *red* or *white* prominences, the base of one of the principal coronal streamers should be taken, the area between a pair of synclinal curves being that chosen for study. The power employed for this work should, perhaps, be about equal to that recommended for the polar rays. The decision as to whether there was a red prominence sufficiently large and bright to form a promising subject for study could probably be made by the time totality had commenced, or almost immediately afterwards, it being borne in mind that the prominences are necessarily most exposed on the E. side at the beginning of totality and on the W. side towards the end.

It is to be hoped that a large number of workers will endeavour seriously to co-operate in this department. This particular study needs to be undertaken and to be thoroughly worked out, and up to the present time it has practically never been attempted.

During the partial phase, both before and after totality there are a number of observations of secondary importance which may very well be undertaken by the users of telescopes of this kind. As a matter of principle the times of all four contacts should be carefully observed.

Similarly, if any spots are on the sun, the times of transit of the moon's limb over them should be carefully noted, both at ingress and egress, and notes of differences of colour and appearance should be made between the umbra of the spot and the body of the moon.

The phenomenon of Baily's beads is worth watching as a spectacle.

The cusps also should be watched as the eclipse progresses, with the special view of seeing if the outline of the moon can be followed outside the sun's disk, and, if so, the distance to which it can be traced and the time when it is so noted should be carefully recorded.

It will be seen from the foregoing that the really important work is the detailed and careful scrutiny of a small selected portion of the corona during totality. The observations which are possible during the partial phase are of very minor importance of themselves, they are, however, recommended to be taken during the oncoming phase as a means of mental occupation and preparation for the work of mid eclipse, and after totality for the sake of symmetry and completeness, but the observer must remember how very great is the change in illumination between the uneclipsed sun and even the inner corona. Some arrangement should therefore be made for a quick change from the projection arrangement or from a proper solar eye-piece to an ordinary one. A prism arranged to give total deflection in one position and a first surface reflection in another would be a very convenient way of overcoming the difficulty.

OPERA-GLASSES.

There is not very much in the way of substantial work to be accomplished with an opera-glass alone, but all those who are going to watch the eclipse merely as a spectacle are earnestly recommended to provide themselves with a good binocular, magnifying some four or five diameters. An opera-glass is so easily carried, and makes such a distinct addition to the optical efficiency of the eye that it should by no means be omitted. Without it, it is to be feared that many will feel disappointed with their sight of the corona. We are accustomed to think of the sun and moon as having an angular diameter much greater than that which they really possess; and the illustrations in popular works on astronomy exaggerate this misconception. Popular pictures of eclipses will give the dark moon a diameter of anything from 3° up to 10°, or even more, and it is apt to come as a surprise when we realise how very small an object it actually is. An opera-glass of the power indicated will not only reveal the beautiful detail of the corona much more effectively than the unassisted eye could do, but will make the spectacle correspond far more nearly to the preconceived ideas.

It is to be hoped, however, that the possessors of opera-glasses will not be content with the mere enjoyment of a beautiful spectacle. Perhaps the most useful thing to do would be to closely scrutinise the whole of the region round the sun embraced in the field of the instrument for the detection of any minute points of light, and such observers should make themselves

perfectly acquainted in advance with the stars in this region of the sky. It is scarcely probable that there are any intra-mercurial planets of sufficient size or brilliancy to be discovered in such a search, but the chance, faint as it is, is not to be neglected, and a good deal of useful information for future searches might result, if observers would carefully record the brightness and position of the stars which they could detect.

A more important search would be for any cometary objects near the sun, and especially to note if there was any appearance of one being more or less mingled with the coronal structure.

Spectroscopic Opera-Glasses.

Mr. A. Fowler, in the "Journal," Vol. VI., No. 6, described an arrangement for adapting a small direct vision prism to one of the members of an opera-glass, and gave a full schedule of the observations which he thought might be undertaken with such an instrument. Since then our ingenious Member, Mr. Thorp, has devised a grating prism to be placed in front of one of the object-glasses of the binocular; an arrangement which has the advantages that a very much greater dispersion is obtained, whilst the opera-glass itself is not altered, and consequently the scale of the image is the same as the tube which is used spectroscopically, as in that which is used in the ordinary method.

The principal work to be done with such an instrument is the comparison of the green ring of *coronium*, as seen in the spectroscopic tube, with the general image of the corona itself as seen in the other. In the eclipse of 1900 it is likely that the coronium ring will be neither bright nor widely extended, and it might be wise for anyone undertaking this observation to keep the eyes at rest for some little while before commencing work, and not to begin observation until totality has actually commenced.

If the green *coronium* ring is seen, its breadth should be most carefully estimated in terms of the lunar diameter, and its structure examined in as much detail as possible. Any irregularities in outline should be noted, and their positions identified as far as possible by reference to prominences, if any such are visible, or if not, to the most distinct and recognisable features of the corona. In particular it should be noted if any rifts seen in the corona itself are reproduced in the green *coronium* ring, and whether any elevations that may be in the green *coronium* ring correspond or not with the bases of the great coronal streamers.

Next in importance to the examination of the green *coronium* ring, is that of the red and blue *hydrogen* rings C and F, and the yellow ring D_3 of *helium*. The height and brilliancy of these three rings should also be examined, if time and opportunity permit, also any irregularity in their outline or difference in slope from the green ring of *coronium*.

With such an instrument the observation of the changes which take place in the spectrum just as totality is coming on or passing off; the time in fact of the appearance of the "Flash" is one of extremest beauty; but the observation of the "Flash" itself with an instrument of this kind is of no direct scientific value, and the

observer who wishes to make a serious examination of the coronal spectrum during totality will probably be well advised to debar himself this sight, at any rate before totality. There is no reason why he should not watch the "Flash" at third contact.

There is one useful thing which the worker with the spectroscopic opera-glass can do, and that is, to give warning of the commencement and end of totality. The latter in particular may be of great service to the photographers near. There will be little or no danger of a photographer exposing his plate before totality has commenced, but he might easily prolong his exposure till after the return of sunlight, and so spoil his photograph. The spectroscopist, however, will have clear intimation that sunlight is about to break forth again by the brightening of the *hydrogen* and *helium* arcs C, D_3, and F, and the appearance of shorter arcs due to some of the metallic lines.

A direct vision prism held before the eye would give the same sight of the rings corresponding to *hydrogen, helium,* and *coronium,* but, of course, they would appear much smaller than in the opera-glass. A small hand or tourist telescope, fitted with a prism in the eye-piece or before the object-glass would give a very good view of the coronal spectrum, but there would not be the second image as in the binocular supplying the direct image with which to compare it.

Yet another form of spectroscope might be used. A slit spectroscope turned towards the eclipse. Here the principal subject of observation would be to compare the relative brightness of the *hydrogen, helium,* and *coronium* lines; for with a slit spectroscope we should necessarily have straight lines and not rings or arcs.

EYE OBSERVATIONS.

The observations which can be made without any optical instrument are sufficiently numerous. The great drawback is that they are seldom attempted with anything like the necessary system or organisation to secure really useful results, and for the most part we are still without enough material to know how best to arrange the details of future attack.

The observations under this head may be grouped in several divisions:—

(1.) Sketches of the corona.
(2.) Observations of shadow bands.
(3.) Observations of stars.
(4.) Observations of shadow phenomena.
(5.) Observations of colours.
(6.) Observations on animals.

(1.) Sketches of the corona may be divided into two classes. Those which are made of the corona proper without the intervention of any disk, and those which are made of the streamers, the inner corona being hidden from the observer by means of a disk.

The method of work in the former case has been already admirably described by Mr. Keatley Moore, pp. 153 and 154 of

"The Indian Eclipse, 1898." Mr. Moore's principal hints may be summarised as follows:—

A sketching party should consist of five persons, four to sketch details of single quadrants, and one to sketch rapidly the general features. The party should repeatedly practice together before the eclipse, always making their sketches on the same scale and using white chalk on purplish-blue paper. A plumb line should be provided for each observer, so that he may make no mistake about the vertical. The sketchers should avoid fatiguing their eyes during the partial phase, and should rest them immediately before totality.

In addition to the hints supplied by Mr. Moore, which should be read at length and very carefully followed out, each sketcher should note as carefully as possible the colours of the corona in his special quadrant, should indicate as precisely as he can the position of any prominence in the region which he is drawing, and should use Mercury and Aldebaran as direction and distance marks. The diameter of the moon also will serve as a unit of distance.

Disk observation is a little different from ordinary sketching, and it may be doubted whether it will yield much fruit except at considerable heights above sea level, and in specially clear atmosphere, nevertheless, we have every reason to expect that the great equatorial wings will show a noteworthy development next May.

A disk observer must be prepared to sacrifice his sight of the actual eclipse on the chance of being able to follow these extensions to an unusual distance. It is, therefore, absolutely necessary for him to keep his eyes in the most perfectly sensitive condition before beginning work, and the disk which is to hide the inner corona from him should be at least 50′ in diameter; and its position must be carefully verified by an assistant at the actual moment of second contact. It seems, however, very doubtful whether the chance of an advantage to be gained is at all commensurate with the trouble and self-denial which disk observation involves; nor is there a single instance in which a disk observation is recorded as having been carried out with real completeness. During a two-minute eclipse, the sun moves its own diameter; the observer, therefore, to really reap the advantage of the disk must move his eye in the contrary direction to the sun at precisely the same rate. He should not look through a hole, as this would certainly hamper his observation as much as the disk could aid it. A device which would effect this would be by no means simple to contrive and certainly has never been used. In all probability, Prof. Newcomb's success in 1878 was due not to the use of a disk, but to the height above sea-level at which he was stationed, to the clearness of the atmosphere and to the care with which he had rested his eyes previous to the observation. A disk of 3° or 4° of diameter would no doubt meet every requirement, but there are few observers with sufficient self-denial as to plant themselves behind a big blackboard during the whole duration of one of the grandest phenomena that nature has to show, on the very slender chance of seeing, or fancying one saw a faint streamer of light across the funereal sky.

SHADOW BANDS.

Mr. E. W. Johnson supplies the following suggestions:—

It is very important at the forthcoming eclipse that the shadow bands should be thoroughly observed at several localities, and as this requires little or no instrumental equipment, it is to be hoped that many will be found to undertake it.

The first essential is to have a large white surface, as it must not be supposed that the bands can be just casually seen. They must be looked for, being very faint as a rule. A sheet or tablecloth is suitable, spread on the ground, or fixed tight between two poles, or on a wall, so that the wind will not disturb it.

The sheet should have two vertical lines or bands of black exactly one foot apart, as it is impossible to judge the distance accurately by the eye, and this would facilitate the task of counting the number of bands which cross any given point in a certain time.

Observers should be quite ready at least five minutes before the time of totality, and should watch until the bands are seen flitting silently across the sheet. They will probably all be seen travelling in the same direction, parallel to each other, becoming gradually more and more distinct, with possibly less space between them, as totality gets nearer.

They will probably be wavy bands, not straight, but they might be slightly inclined to their direction of motion. A good plan is to have ready two straight rods, which must be placed parallel to the direction of motion of the bands, and left in position until after the eclipse, when the exact direction can be ascertained by the compass, one rod being used before totality, and the other after totality. If two observers are watching at any one place, it would be as well for one to have a sheet spread on the ground and the other with a sheet vertical.

Those who observe the approach of the moon's shadow in the sky should say whether it comes uniformly or in jerks, and then notes can be compared with shadow-band observers, as the bands might appear all travelling uniformly or in batches.

The bands are dark bands, and their speed varies very much at different eclipses, and their direction is probably influenced by the wind. They should certainly be looked for after totality, and even during totality. They do not seem to have ever yet been photographed. Let us hope that someone will meet with success in this direction on 28th May next.

I would enumerate the following questions for shadow-band observers to endeavour to answer:—

Questions.

1. How long before totality did the bands appear?
2. What number of bands were visible, say, in 10 seconds?
3. What was the direction of motion?
4. Where they inclined to the direction of motion?
5. What was the direction and force of the wind?
6. Did they come uniformly, or in batches?
7. What was their speed?
8. What was the width of the bands?

9. What was the distance apart of the bands?
10. Were they very faint, or clearly defined?
11. Was their direction after totality the same as before?
12. How long after were they visible?
13. Did you see any bands during totality?

To the foregoing suggestions it may be added that a smooth and newly-whitened wall would make about the best vertical receiver for the shadow bands, and that, if possible, at each station two or three vertical planes should be used as well as at least one horizontal. If possible, the vertical planes should face in somewhat different directions, one directly facing the eclipse, the others at angles of about 30° or 40° with it. But in each case the exact azimuth faced by the plane must be precisely determined.

Observations of Stars.

The search for stars during totality will be specially interesting during the approaching eclipse because of the rich portion of the heavens through which the sun is then passing. Aldebaran is the nearest bright star, consequently Orion, Sirius, Procyon, the Gemini and Auriga, the Pleiades and Perseus, are all in the quarter of the heavens to which attention should be turned. Mercury precedes the sun some 2°; Venus at her greatest brilliancy follows at 45°. The map which Mr. Crommelin has prepared should, therefore, be very carefully studied. The exact position of Venus might easily be obtained before the eclipse begins, and in all probability the planet will readily show herself, if not before first contact, at least early in the partial phase. Venus and the sun thus being readily recognised, the exact position of all the principal stars given in the little map can be picked up with great readiness, and it will be a matter of much interest to note at what moments each star is first perceived. The object should be to identify with exactness as many stars as possible before or during totality, noting the time at which each was recognised. After totality, the times when the stars are successively lost should be also recorded.

It has been occasionally suggested that search might be made for the zodiacal light. It may well be doubted whether there is the slightest possibility of any glimpse of the light being caught during an eclipse, even under the most favourable conditions. A moon two days old is quite bright enough to overpower it, and the total light of the corona is several times greater than that of the full moon. The eclipse of 1901 would offer a much better chance, but even then there is no real probability of detecting it.

Miscellaneous Observations.

There are a number of miscellaneous observations which, though not of any great scientific importance, should not be overlooked by those who are not devoting themselves to any special department of work. It should be borne in mind by all who are favoured by a sight of the eclipse how extremely rare are such opportunities as they are then enjoying, and there is a

certain moral obligation upon everyone so favoured to notice and to record at least something that may be of interest or value to those less fortunate than themselves.

If a high station is available, commanding a wide view of land or sea, the observer should face westerly as the partial phase grows towards completion and watch for the approach of the shadow. The exact azimuth to which he should turn his attention will depend upon his position, whether it is on the line of central totality, or north or south of it.

Similarly the observer should turn directly the shadow has reach him, and watch its recession after third contact. The time at which the shadow reaches the station and leaves it again should be carefully noted. This should be done even if clouds hide the actual eclipse from view, even if the actual shadow cannot be perceived, the going and returning of the light may be timed with considerable accuracy.

The colours of sky, land and sea furnish another class of observations especially suitable for those who have artistic training. These observers, and those who are watching the shadow will find it to their advantage to observe the same precaution, should in some way or another accurately mark out for themselves the principal points of the compass. If several observers are available at a given station, they should divide the horizon according to their numbers. A quadrant to each observer, if there are four, would be a very convenient arrangement, the sun being in the centre of one of the sections. Each observer should record his observations under the three times divisions of "before totality," "during totality," and "after totality," and under the five heads of "land," "sea," "sky at horizon," "sky at sun-height," and "sky overhead"; it being especially specified whether the sky in the last three divisions is clear or whether clouds are present.

With regard to the division "sea," it may be noted that in the eclipse of 1896, at Vadsö, a curious lighting up of a small area of the waters of the fjord was noticed during totality, although it was then in full shadow, and, so far as could be seen, there was no break in the clouds. The repetition of such a phenomenon might be looked for, and if it recurred, it might be possible to trace its cause.

With regard to observations on birds and animals, it seems quite unnecessary to give any directions.

Meteorological Observations.

It is to be hoped that if there are any Members going out on the expedition who are thoroughly accustomed to take meteorological observations, that they will imitate the example of the Rev. J. C. Mitchell in our Vadsö Expedition, and take out a complete set of instruments. There should be one fully equipped meteorologist at each of the stations occupied by association. But if shadow-band observations are undertaken at any station, it should be remembered that it is of great importance that the direction of the wind should be taken at the moments of second and third contacts. Should there be clouds in the sky, the

direction or directions of their movements (in case that there are two or more layers not in the same current) should be observed; and in the latter case it should be carefully distinguished as to which is the higher and which the lower stratum. The speed and force of the wind should also be estimated if possible, and this not merely during totality, but at a number of short intervals, beginning before first contact and prolonged after the last.

Photographic Work.

The progress of photography has opened a very wide field to amateurs in eclipse work, a field in which many valuable results may be secured.

First of all, come photographs of the corona with fixed cameras. This subject has been pretty fully dealt with in the "Indian Eclipse, 1898," p. 158, &c. With a camera of 5-foot focus, firmly and rigidly fixed, an exposure of two seconds means a blurring of about one-hundredth of an inch, which, as one of Mr. Fred Bacon's photographs shows, is quite consistent with a fair image. This is the limit of exposure for that focal length, and it would be much better to consider that one second was the limit for a 5-foot focus. For shorter focal lengths, the exposures might be longer, but it will be found that if the focal length is not more than 13 times the aperture, one second will give an admirable picture of the whole of the lower corona, even with an "ordinary" plate; whilst for a plate of extreme sensitiveness such an exposure would probably prove excessive. Except in two cases, to be referred to immediately, a rigidly fixed camera, and an exposure not exceeding one second at the outside (if there be opportunity it will be well to give several much shorter exposures), will give the best results for pictures of the corona.

The exceptions are these: If a lens of very long focus in proportion to its aperture be used, or if the image of the corona be enlarged by a magnifying lens, either positive or negative, in the camera, the one second exposure may prove inadequate and it will be necessary by one device or another to follow the sun. So, too, as pointed out in the Eclipse Report, pp. 162 and 163, if it is desired to secure the faint outermost extensions, a very greatly prolonged exposure must be given, and the camera must, therefore, follow the sun.

A photographer who is experienced in hand-driving might find it sufficient to point his guiding telescope upon the planet Mercury, and to dispense with a driving clock, but only one who had attained great skill in such work should attempt it. It is not an experiment which is in the least likely to be attended with success if tried for the first time during a total eclipse.

Mr. W. Shackleton suggests that it will be well worth while attempting to photograph the corona by light as nearly monochromatic as possible. This should be effected partly by the use of a film of special colour sensibility, and partly by the use of a colour screen. The object being to limit the reflective sensibility of the plate to the immediate colour of the green *coronium* line. Of course the combination of the two would have to be tested carefully on the spectrum to insure that their sensitiveness was of the quality demanded, the object being to find out what

portion of the corona was really due to *coronium*. A similar investigation would be worth trying, and would be decidedly easier to carry out with regard to the D_3 line of *helium* or the F or G lines of *hydrogen*.

PARTIAL PHASE.

With regard to photographs of the partial phase Members are referred to p. 166 of "The Indian Eclipse, 1898."

BRIGHTNESS OF THE CORONA.

Three methods were employed in India for obtaining a record of the total brightness of the corona or of the degree of illumination due to the eclipse. The first two of these consisted in photographs of the landscape or in the exposure of sensitive plates to the general light of the corona. On the first method Miss Gertrude Bacon, who initiated the observation and carried it out in India, writes as follows :—

PHOTOGRAPHS OF THE LANDSCAPE.

The curious difference in rapidity of the coming on and going off of the darkness before and after totality, revealed in a series of exposures made by me in India, claims confirmation and elucidation at the forthcoming eclipse. More particularly it would be desirable that more than one observer attempt the experiment, so as to minimise possible error or accident. The exposures being made during the partial phases need not interfere with work undertaken during totality, and the simplest instrumental aid only is required.

It is necessary merely that the observer be provided with a camera fitted with a shutter that may be trusted to work accurately at the same speed. With this a series of exposures of a portion of the landscape should be taken, at equal and carefully timed intervals before and after totality, and subsequently developed under exactly similar conditions, when any difference in density could be at once detected.

The more exposures made the better, of course, but it is specially recommended that two at least be taken in the five minutes immediately preceding and following totality, say at five and three minutes before and after respectively. It has been suggested that the cause of the observed phenomenon has lain in the condensation of moisture in the atmosphere during the chill of the total phase, and this cause may be supposed to disappear soon after the return of sunlight.

It is essential that the plates or films be all of one brand, and carefully marked for identification. Those taken at corresponding intervals previous to and after totality should be developed in pairs in one dish, so as to render conditions precisely similar.

The portion of landscape photographed should be to the northward, or at least away from the sun. Foliage against sky is good for the purpose as showing the relative density of the plates specially well.

The suggestion has been made that a camera is not absolutely necessary for this work, a simple apparatus that should give

uniform exposures of the general light on, say, a piece of bromide paper, doing equally well. We ourselves propose trying in America an instrument that shall automatically expose a long roll of sensitised paper or film, winding through continuously during a considerable space of time.—GERTRUDE BACON.

With regard to integrating photographs, Members are referred to pp. 129 and 167 of "The Indian Eclipse, 1898," and Mr. Gare supplies the following additional suggestions:—

A Photographic Determination of Coronal Brightness.

An attempt was made at Buxar in 1898 to determine the brightness of the corona by means of the exposure of a photographic plate behind a graduated screen. It is now proposed to make a similar experiment at all the stations of the British Astronomical Association during the forthcoming eclipse, and if this is done it should yield evidence not only as to the intensity of the coronal light, but also as to whether it varies with changes in coronal form, and to what extent it is affected by local atmospheric conditions. The experience gained at the Indian eclipse and from exposures of comparison plates in this country, has suggested that the exposure to be adopted should not exceed 30 seconds, using slow or "ordinary" plates, which should be backed to minimise halation. Sensitometer screens similar in form to that used in India are being prepared, and as the apparatus required is exceedingly simple, consisting essentially of the screen, plate, and dark-slide, it is hoped that a sufficient number of Members will be found who are willing to undertake the exposure of the plates at the various stations.

A point of additional interest would be a repetition by these means of Miss Bacon's interesting observation of the differing intensity of sunlight before and after totality.—F. GARE.

Twilight Illumination.

The attempt to parallel the general illumination during mid-totality with that at a given time during twilight is one that will be only successful in tropical countries, where the progress of twilight is rapid, and where in consequence its phases bear a closer relation to the effects during the progress of an eclipse. Nevertheless, it would be well to watch the twilight carefully on the evening after the eclipse for the purpose of ascertaining how far it corresponded to the eclipse effect, when it most resembled it, and in what particulars it differed from it. Here, as in all time determinations, it is essential that the precise error of the chronometer or watch be known.

In reviewing all these different forms of observation, I should like to be permitted to express my personal conviction that the photographic observations, whether photographs of the corona, of the partial phase, of the landscape, or integrating photographs, come first in order of value and importance; careful sketches, whether of the telescope or without optical aid, systematic meteorological observations and determinations of the lines of contact should come next, and, finally, the various miscellaneous observations which have been referred to above.—E. W. MAUNDER.

Dr. Downing has kindly supplied the following note:—

POLARISCOPIC OBSERVATIONS.

It may be assumed that the light of the corona is radially polarised, the vertical polarisation that has sometimes been noticed being, it may be presumed, due to the earth's atmosphere. The point to which observers should now devote attention is to determine at what distance from the sun's limb the radial polarisation is most intense; the determinations being made, if possible, in different quadrants. Observers should, of course, verify the fact that the polarisation measured is radial.

There are so many different forms of polariscope that definite hints on the actual mode of observation cannot be given in a brief communication, but the point to emphasise is that some form of *polarimeter* is essential, by means of which the relative intensities of polarisation in different parts of the corona can be measured. Probably the most handy form of instrument is a Savart's polariscope with rotating plates of glass to act as depolarisers, such as is figured in "Memoirs" of the Royal Astronomical Society, Vol. XLI., page 318, and which can be used either with or without a telescope.—A. M. W. DOWNING.

Total Solar Eclipse of May 28th, 1900.

By Dr. A. M. W. DOWNING, F.R.S.

1. Cape Matifou:—

Adopted position - - { 3° 15′ E. longitude. 36° 48′ N. latitude.

	h	m	s
Eclipse begins May 28 - -	3	5	
Totality begins - - -	4	17	24
Totality ends - - - -	4	18	35
Eclipse ends - - -	5	22	

These are Greenwich Mean Times.

2. Menérville:—

Adopted position - - { 3° 35′ E. longitude. 36° 43′ N. latitude.

	h	m	s
Eclipse begins May 28 - -	3	5	
Totality begins - - -	4	17	42
Totality ends - - -	4	18	53
Eclipse ends - - -	5	22	

These are Greenwich Mean Times.

For both these positions the first contact takes place at 274° from the sun's north point, and 214° from the vertex. The last contact takes place at 94° from the north point, and 37° from the vertex. The position-angles of the second and third contacts are, for the first station, 102° and 264°, and for the second station, 95° and 272°. All these angles are reckoned in the counter-clockwise direction. The sun's altitude at totality is 29°.

Observers are warned that, judging from the results of recent total solar eclipses, the above durations of totality are, perhaps, as much as three seconds too long.

Notes on the Total Solar Eclipse of May 28th, 1900.

By A. C. D. Crommelin, F.R.A.S.

Two diagrams accompany this note; the first shows the position of the more important points and lines on the sun's disk at the time of the eclipse; the second shows the stars and planets in the neighbourhood of the eclipsed sun.

With regard to the first the following angles may be conveniently tabulated here:—

Angle from vertex to N. point of disk Ovar, 51½°, Talavera, 54°, Alicante, 56½°, Algiers 58½°.

Angle from N. point of disk to sun's N. pole, 16° 51′. (This is also angle between line parallel to our equator and sun's equator.)

The centre of the sun's disk is in S. heliocentric latitude 0° 55′.

Angle between line parallel to equator and ecliptic, 9° 41′.

If the corona be of the same type as in 1878, the longest streamers will probably be nearly in the direction of the sun's equator, while there will be numerous short "plumes" near the sun's poles.

It will be seen from the other diagram that the sun will be in Taurus not far from Aldebaran. The 4th and 5th magnitude stars κ^1, κ^2 Tauri will be within the corona. To the left of the sun Orion and Sirius, above Auriga and Gemini, to the right Perseus, while Mercury will be some 2° low, right of the sun, and as its disk will be fully illuminated, and it will also be near perihelion, it will be quite a conspicuous object. In fact the possessor of a good instrument might do worse than devote totality to a critical examination of Mercury.

Venus at its greatest brilliancy in the middle of Gemini will be visible with the naked eye before the eclipse begins at all, and will be resplendent during totality. There are an unusual number of bright stars round the sun, and it will be interesting to see how many of them can be detected with the unaided eye.

A few words on other astronomical work that may be done during the trip. For many of us journeys so far south are few and far between, and we shall naturally be desirous of studying the new region of the heavens that is opened up to us. Unfortunately the Southern Cross and α Centauri will still be hidden. The following are the constellations that will be brought into view wholly or in part: Malus, Vela, Anteia, Centaurus (part), Lupus, Scorpio (whole), Southern Cross, Sagittarius (whole), Microscope, Grus, Piscis Australis.

The zodiacal light may be visible, though not to such advantage as it would be earlier in the year; but the probable clear skies and shorter twilight will be in its favour. Venus, Jupiter, and Saturn will be very favourably placed for observation, and those who are bringing out telescopes of fair size may expect to obtain very much better views than would be possible at home.

There is an observatory at Algiers, and it will doubtless be possible to compare watches and chronometers there, so it will not be necessary to make observations for time.

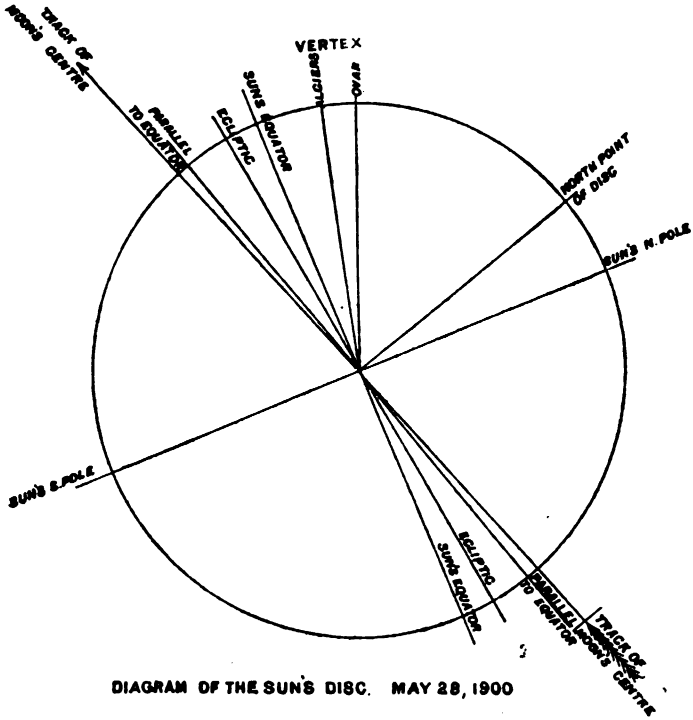


DIAGRAM OF THE SUN'S DISC. MAY 28, 1900

We may probably count on having 64 seconds of totality at Algiers. The Nautical Almanac data give 67 seconds, but from the experience of 1898 it will probably be less than this.

The velocity of the shadow at Algiers will be about 46 miles per minute; from the high ground behind the town it will probably be possible to witness the shadow approaching for several seconds before totality, and receding on the east of the bay after totality.

It is to be hoped that observations of the shadow bands and other attendant phenomena will be made, also determinations of the brightness of the corona, but these will doubtless be more fully dealt with in other notes. Reference should be made to the suggestions published in the "Journal" before the eclipse of August 1896.

Defective Definition of Reflectors.

By EDWIN HOLMES.

Some two years ago Prof. Schaeberle, in No. 413 of the "Astronomical Journal," published a paper dealing with the defective definition of reflecting telescopes and investigating the cause or causes. I believe another paper appeared in P.A. for October, 1897, and there was also a reference to the same subject in "Nature," May 26, 1898. Short summaries of all these are to be found in our own "Journal."

Prof. Schaeberle was led to the mathematical investigation of the matter in consequence of the unsatisfactory performance of the Crossley 36-in. mirror, and he found a cause which tended to defective definition in several ways. He pointed out that owing to the fact that the focus of a parabola is not at its centre of curvature, the outer portions of the mirror, being more distant from the focus than the centre is, must produce larger focal images, and thus the resultant focal image is made up of a number of overlapping images of sensibly varying size, which produces blurring aberration in a manner for which there is no remedy.

Again as the rays from various portions of the mirror reach the focus at various inclinations to the axis, and each portion *taken separately* forms an image at right angles to its path, the resulting focal image is really made up of an indefinite number of images, in different planes, and this, again, spoils definition in a manner for which there is no remedy.

And yet, again, the distance betwixt two adjacent points of the image would depend upon the portion of the mirror from which the light is reflected, that is, the linear distance betwixt two points in the image would vary for different annuli of the mirror. The consequence is that a series of overlapping images are formed, and the amount of blurring increases very rapidly as the image recedes from the optic axis.

I think everyone accepted this argument. The grounds of it are sound and the mathematics irrefutable. I accepted the conclusions fully for some time. That the margin of a mirror is farther from the focus than the centre is true, and therefore any portion of the margin *taken alone* must form a larger spurious disk and a larger image than a portion at the centre, and the rays from any portion at the margin do strike the axis at an inclination, and if this *alone* is considered, must form an image at right angles to their path. There appears no room for error, and yet, as time went on, I became less satisfied until I began to ask myself if some fallacy might not exist. My own instrument, according to this conception, would form images in planes inclined nearly 9° to each other, which it certainly does not, and I have at last come to the conclusion that while both premises and argument are correct there is an underlying misconception when we consider the mirror as a whole.

Suppose we take a mirror of 3 feet diameter and 18 feet focus, and cover its surface with a plate perforated with 3-inch holes as closely as possible. Let us cover all except one marginal aperture, and examine a star or a double star at the focus. We shall evidently find a spurious disk or disks of such dimensions and brilliancy as a 3-inch aperture of about 18 feet focus produces. If we uncover another 3-inch marginal aperture we shall have still the same sized disk, but with twice the light. If we uncover a third or any number of marginal apertures, we shall still find our disks the same size (except for irradiation), but with light in portion to the number of apertures. Let us now cover all but one 3-in. aperture near the centre. We shall again find the disk or disks and light which a 3-in. aperture will produce at a slightly shorter focus, that is to say, slightly smaller and at a less dis-

tance apart. If we now uncover a marginal aperture we shall evidently superpose two disks of each star of different sizes and in different planes, and if we uncover the whole of the 3-in. apertures we shall have an equal number of superposed disks of as many different sizes as there are different distances from the centre, and in as many different planes as there are apertures. So far this agrees exactly with Prof. Schaeberle's conclusions.

If we make our apertures six inches, exactly the same conclusions follow, only the number of superposed disks is reduced in proportion to the less number of apertures, and the number of planes is reduced also, and the disks at focus are reduced to half their previous diameter. A further increase in the size of the apertures still further reduces the number of planes and disks, and the size of the disks also, until it is quite fair to infer that with the one aperture only of the whole mirror only one spurious disk is formed in only one plane, and reduced in size in exact proportion to the increase of aperture.

If we reduce the size of our apertures, on the other hand, we increase the size and the number, and the number of planes of the spurious focal disks, until, when the circular apertures become infinitely small and infinitely numerous, the superposed spurious disks also become infinitely numerous, and in an infinite number of planes, and infinite in diameter.

No doubt I shall be told this is equivalent to uncovering the whole mirror, but that is just what it is not; and I venture to say it is just here the misconception comes in. Prof. Schäeberle has treated the mirror as if made up of separate portions, each producing a separate image, whereas we have to consider the mirror as a whole. It is often convenient to regard a mirror as if made up of numberless small mirrors, but it does not so act when producing the spurious disks of stars or minute detail. The focal image of a star is not manufactured in that way. It is an interference phenomenon, and its diameter is greater or less as the result of the angles at which the waves cross. The more obtuse the angle, or, rather, the less acute, at the focal point, the smaller will be the spurious disk for the same focal length. The image of a star is not a composite image—not an accumulation of images formed by various portions of a mirror—but is one only, and in one plane only, and is the result of the mirror as a whole, and not as an assemblage of parts working more or less discordantly. Of course I am aware that for an image of any size, what I have called the focal plane is a curve, but I am not treating of curvature of field.

The discussions which have taken place upon the subject, however, have not treated a mirror as if made up of small mirrors, but as consisting of zones. It is, perhaps, necessary to show that this does not affect the reasoning. Admitting for a moment only that an annulus can produce a disk, what would be the result? Evidently we can only consider the action of narrow annuli in conjunction with a central aperture. It is stated that when the proportion of focal length to aperture is 14 to 1, no discoverable defect occurs, so illustrating by a 12-in. mirror of 80-in. focus, the central 5½-in. will produce a practically perfect image, and will result in a spurious disk to a star, about 0″·8 diameter.

Now, if we take a zone half an inch wide round this according to our doctrine of separate action, it will produce a larger spurious disk, and superpose it on the original 0″·8, and so on, with each zone to the outer annulus 12-in. diameter, which will produce the largest disk of all. Now, every one of the zones produces larger spurious disks than the central aperture alone produces, and, therefore, cannot reduce the diameter of the spurious disk produced by that central aperture, but must increase its size, and, therefore, the wider the aperture the larger must be the star disk. This you all know to be contrary to fact, and the reasonable inference is that the mirror acts as a whole in producing the focal image and not piecemeal, and that the image is one only and not a composite of superposed images.

If we study any zone alone the action is rather peculiar, for (still supposing it can produce a disk) then the rays from opposite ends of any diameter of outer zone would produce disks in planes at an angle of 8° or 9° to each other, and every point of the annulus would make an image in a different plane to any other, and the sum of the action would be an image in a multitude of planes.

But a narrow annulus of wide diameter has very little effect in producing a spurious disk at all. It throws most of the light into a ring, with fainter rings both inside and outside it. These are mostly broken up by atmospheric unsteadiness, and the unsteadiness causes the flares and spikes, with which everyone is familiar who has experimented with narrow zonal stops. This failure of image is quite irrespective of the goodness of the figure of the annulus employed.

I have so far referred only to the case of a single or close double star in the optical axis. There must be some deformation of figure of disks as we depart from the axis of the telescope, but except for this the same considerations apply to other stars in the field as to one in the centre. They are equally the effect of the action of the entire mirror, and the definition of the stars in the outer portion of a star-cluster would not be spoiled by the superposition or partial superposition of disks in different planes any more than the central star.

And as the focal image of a body of sensible size, like a planet, or the moon, is made up of points, and each point, like the image of a star, is the product of the whole mirror, and also like that of the star, is as perfect as the slight inclination to the axis permits, the entire image is not made up of superposed images of different sizes and in different planes, but is one only, I think we must seek elsewhere for the cause of failure of large reflecting telescopes.

The presence of the flat and its supports is injurious to definition. The flat acts as a central stop, and interference phenomena result, radiating outwards as they do inwards from the circumference. In the Crossley reflector I have read that to avoid risk of spoiling the figure of the flat it is used in a circular form, and not cut elliptic. It therefore acts as a central elliptic obstruction. This would interfere with the perfection of both spurious disks and rings.

Where the Day Changes.

By A. M. W. DOWNING, M.A., D.Sc., F.R.S.

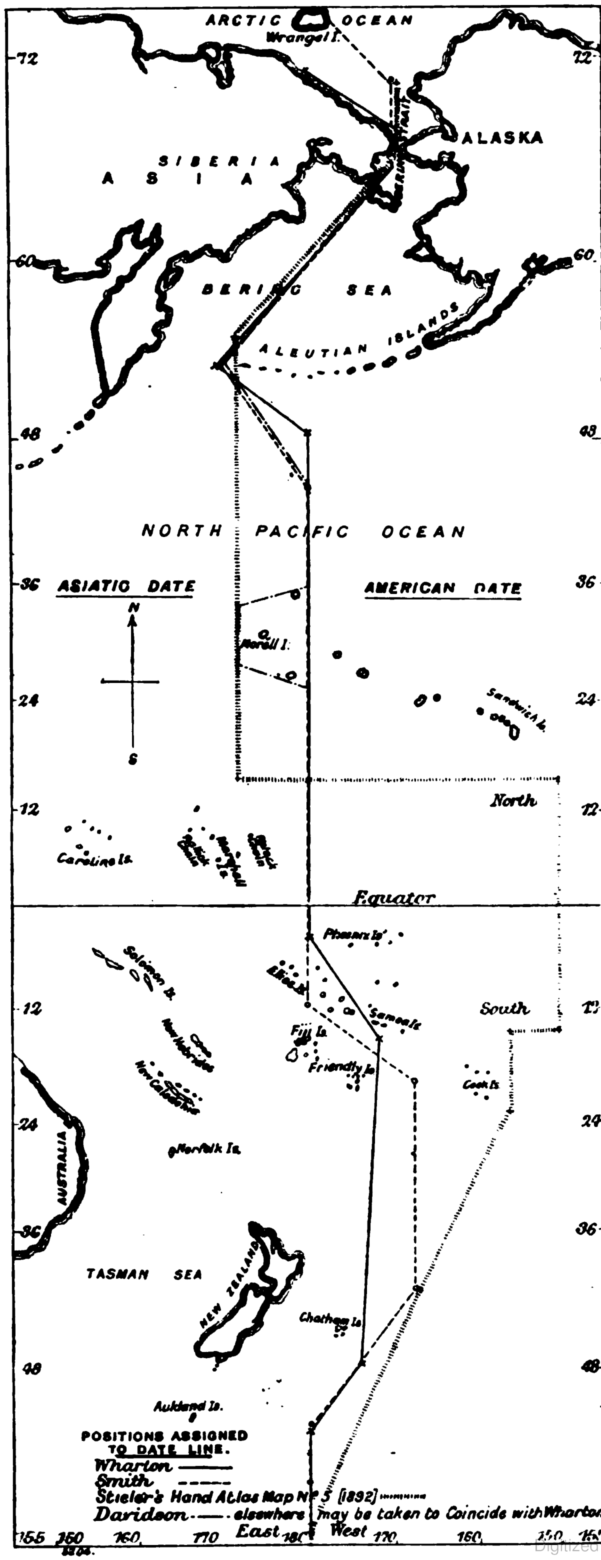
It is unnecessary to remind the Members of this Association that when travelling east-ward from this country, for instance, the local time is ever more and more in advance of English time, and that the reverse is the case when travelling westward. So it comes about that by the time the traveller, in the first case, reaches the 180th degree of longitude his time is 12 hours in advance of the time of his initial meridian, and, in the second case, is 12 hours behind that time. Thus, when it is six o'clock of the afternoon of Wednesday in London, to the eastward-going traveller (in the case supposed) it is six o'clock of the morning of Thursday, whilst to the westward-going traveller it is, at the same time, six o'clock of the morning of Wednesday. To set things right, therefore, it is necessary, in the first case, for the traveller to call two successive days "Thursday," and, in the second case, omitting the Thursday altogether, to pass from Wednesday to Friday. This is the practice observed in ocean-going ships when crossing the 180th degree of longitude, and is sufficiently familiar to us stay-at-homes by the many travellers' tales we have read, the authors of which give us humorous or sentimental reflections on the subject, according to temperament.

But there is another point in connexion with this matter to which I wish to draw your attention more particularly. It is this. Where does the day change for the portions of the continents and the islands which are contiguous to the 180th degree of longitude, or, in other words, what is the course of the date line (as it is called) from the Arctic to the Antarctic regions? When it is Wednesday on the east side of the date line it is Thursday on the west side, and the day may be considered to begin at this line.

It is obviously most convenient that the date line should approximate, as closely as political and other circumstances will admit, to the 180th degree of longitude. Prior to about the middle of the present century this was far from being the case. Up to that time the Philippines kept the American date, owing to the fact that the Spaniards originally approached those islands from the Pacific Coast of America. Thus Luzon and Celebes, though on the same meridian, kept different dates, the former the American, the latter the Asiatic. To remedy this inconvenience the Archbishop of Manila decreed that the 30th December, 1844, should be immediately followed by the 1st January, 1845, thus adopting the Asiatic date for the archipelago under his jurisdiction.

The purchase of Alaska by the United States had also its effect in straightening the date line, as this territory which had formerly kept the Asiatic date, from henceforth, of course, adopted that of America.

Further changes in the direction of the assimilation of the date line to the 180th meridian would, at present, be difficult, as its course is mainly determined by the grouping of the islands, and by the particular circumstances in each group upon which depends the direction in which it has intercourse with the outer world.


ARCTIC OCEAN
Wrangel I.
ALASKA
SIBERIA
ASIA
BERING STRAIT
BERING SEA
ALEUTIAN ISLANDS
NORTH PACIFIC OCEAN
ASIATIC DATE
AMERICAN DATE
N
S
Morell I.
Sandwich Is.
North
Caroline Is.
Equator
Phœnix Is.
Solomon Is.
Ellice Is.
Samoa Is.
South
Fiji Is.
New Hebrides
New Caledonia
Friendly Is.
Cook Is.
AUSTRALIA
Norfolk Is.
TASMAN SEA
NEW ZEALAND
Chatham Is.
Auckland Is.
POSITIONS ASSIGNED TO DATE LINE.
Wharton
Smith
Stieler's Hand Atlas Map No 5 (1892)
Davidson — elsewhere may be taken to Coincide with Wharton
East
West
72
60
48
36
24
12
155
160
170
180
150

These circumstances may, of course, alter as time goes on, and may be followed by corresponding changes in the position of the date line. But the assimilation, if carried out at all, must be a gradual process.

A glance at the accompanying map will show the strange disagreement that, at the present time, exists in the position of the date line as laid down by the different authorities I have been able to consult. The most remarkable divergence is in the case of the line given in Stieler's Hand Atlas. But as the atlas is dated 1892, this position of the date line may, perhaps, be considered as not being quite up-to-date. The line marked "Wharton" is that of our own Hydrographic Office, and was kindly communicated to me by Admiral Sir W. Wharton; that marked "Smith" is taken from an interesting article in the Century Magazine for September of last year, by Mr. Benjamin E. Smith, who, however, does not give his authority for the position of the line; that marked "Davidson" is due to Prof. Davidson of the University of California, and was kindly communicated to me by Prof. Harkness, of Washington.

It will be noticed that Wharton and Davidson only differ in unessential particulars, affecting one small group of islands. We may, therefore, conclude that we have in these two lines an almost certainly accurate delineation (with the exceptions referred to) of where, at the present time, the day changes.

Correspondence.

Observing Weather in 1899.

The accompanying table shows the observing conditions prevailing in London, S.W. (at Westminster or Clapham Common—positions only about two miles apart) in 1899. It is constructed on precisely identical lines to that described in the "Journal," Vol. IX., No. 7, page 326.

Class.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Total.
5	2	—	—	—	2	1	—	2	1	1	1	1	11
4	1	5	1	2	6	5	2	8	3	3	—	1	37
3	—	4	9	5	4	4	8	7	10	4	2	1	58
2	8	2	6	2	5	5	6	5	4	4	3	2	52
1	5	3	2	5	5	4	4	3	1	3	4	—	39
0	15	14	13	16	9	11	11	6	11	16	20	26	168

The finest nights have, unfortunately, coincided for the most part with bright moonlight.

Meteors have been recorded on 28, and variable stars observed (almost wholly with the unaided eye) on 27 dates.

75, The Chase,
Clapham Common,
1900, January 1.

WALTER E. BESLEY.

Enlargement of Heavenly Bodies near the Horizon.

As a small contribution to the discussion at present being carried on in the pages of our "Journal," I should like to be allowed to reiterate a personal experience which I have described on former occasions both orally and in print.

It is, or was, that of observing a balloon passing over my head at an elevation of perhaps half a mile; when it appeared a very small thing indeed. When, however, it descended about a mile off, it seemed, as it approached the earth, to be an enormous object in the landscape, and I confess that this strongly inclined me to accept Sir John Herschel's view of the seeming enlargement of the sun, moon, and the constellations when near the horizon, being referable to our unconscious comparison of them with objects whose distance is familiar to us.

Forest Lodge, Maresfield, WILLIAM NOBLE.
Uckfield.
1900, January 24.

Enlargement of Heavenly Bodies near the Horizon.

I read the paper of Mr. Dolmage and the discussion at the October Meeting with some interest, because it presented a new view of the matter to me. I had thought the supposed enlargement of the sun and moon upon the horizon was only observed when the air was thick and not when the air was clear, and was not aware the constellations also underwent apparent enlargement. I believe it is a fact that the sun and moon loom large on the horizon on many occasions with a hazy or smoky sky, but personally I have never seen anything of the kind with a clear sky. Neither sun, moon, nor groups of stars give me any impression of increased size in such position when the horizon is clear. I doubt any general agreement with such proposition. I have asked several non-astronomical people in which place the sun and moon look largest and I receive for answer that the size is the same anywhere. (I have said, of course, with a clear sky.) There is no difference they say. I note it was said that photographs and micrometer measures made low down refute any real enlargement but I suppose neither photographs nor measures have been made with a misty atmosphere to produce enlargement and it is only under such conditions, I conceive, such apparent enlargement takes place.

Since reading the explanation that we conceive the sky as ellipsoid and much nearer at the zenith, I have also put the inquiry to one or two people whether, with a blue sky, does the sky look more distant overhead or low down, and have received for answer that low down looks about as distant as the most distant terrestrial object, but overhead seems far more distant, which is also my own conception. So here is another factor in the case. Why do only some people see this enlargement and flattening? If it were not for the constellations also being seen enlarged I should be of opinion that the idea of the apparent enlargement being a constant phenomenon proceeds from noticing that a thick air sometimes enlarges, and that it is only when the air is thick we can comfortably look straight at the sun, and

giving special notice to these occasions we conclude the particular case is also general, and that enlargement always is apparent when, as I think, it is not.

EDWIN HOLMES.

Apparent Enlargement of Heavenly Bodies.

I was unfortunately not able to attend the Meeting of the British Astronomical Association, held on 25th October 1899, and so missed hearing read Mr. Cecil G. Dolmage's paper "On "the Apparent Enlargement of Heavenly Bodies when in the "Neighbourhood of the Horizon." But I think the discussion of a paper bearing only about half the foregoing title would not be uninstructive; and that is my reason for the title of this.

There is a curious biped extant, commonly known as the British working man, whose prevailing characteristic seems to be chronic thirstiness. Some years ago I demonstrated to one of these individuals that the full moon then on view did not appear so large as did a threepenny piece held at arm's length between it and the eye.

My pupil disappeared as soon as he could graciously get away; and when he again presented himself his face was wreathed in smiles as he assured me he had been getting a pint of beer out of somebody on the merits of what I had just before told and shown him respecting the moon. The moral of it all was, that although the full moon did not appear so large as the coin it nevertheless looked larger: and so far as I know the reasons for such a contradictory aspect of things has yet to be found.

Most emphatically "irradiation" will not supply the explanation; for to decide this point I last night experimented with a threepenny bit and the not far from full moon; and this morning I have taken advantage of a hazy atmosphere to compare the sun with the same coin. Held at arm's length this small silver disk proved large enough to totally eclipse both moon and sun, as of course it should; then moved slightly so that the edge of the coin was brought into juxtaposition with the limb of the moon or the sun, it (*the coin*) *was seen to be considerably larger than the apparent size of either luminary*. But—here is the curious thing about it—on laying the threepenny bit in the palm of my hand and viewing alternately the moon and the coin, or the sun and the coin, *both luminaries looked at least two or three times larger than the little silver disk*. Evidently some subtle optical peculiarity is responsible for it all, and it does not just now appear possible to arrive at a closer decision. I should expect the "irradiation" effect to be most manifest when coin and luminary are juxtaposed, but the outcome of my experiments warns me that I should then be disappointed.

In the "Jubilee" year (1887) I had a new threepenny bit mounted "head" forward as a scarf-pin. I kept it well polished and wore it against a black or very dark silk scarf.

It looked so large in that position that it furnished much amusement to hear my acquaintances from time to time guessing its value. In, I think, every case it was finally set down as a sixpence; its actual value was *never* mentioned. But everyone

to whom I explained what was its denomination unhesitatingly replied, "Then it is about the biggest threepenny bit I ever saw." And yet it measured very approximately five-eighths of an inch, whilst a sixpence measures about one-eighth of an inch more. I set this down at the time to "irradiation," but I doubt now if I was right in so doing.

WILLIAM GODDEN.

Jupiter's Equatorial Current.

In No. 2, Vol. X., of the "Journal" of the British Astronomical Association, there appears a critique by Mr. Crommelin, on my paper about "Jupiter's Equatorial Current," which renders it necessary that I should add a few words to the latter so as to prevent mistaken or premature conclusions.

If Mr. Crommelin has fully considered my paper he will have, no doubt, observed that I did not forget the extreme weakness of the universal gravitation. But, nevertheless, it is not possible to deny that a feeble acceleration may produce formidable results. The moon, for instance, whose attractive force on the earth is represented by an acceleration of only $\frac{1}{29}$ mm. produces, notwithstanding, in the ocean the gigantic motion of the tides, which represents an immense mechanical work.

It is very probably a fact that in Jupiter's equatorial current much less energy is employed than in the lunar tides in spite of the great velocity of the said equatorial current, since the highest strata of Jupiter's atmosphere are formed of perfect gas, the loss of motion by friction being relatively almost nil.

However, there is no difficulty in accepting the existence of a certain number of small satellites close to the planet, whose joint action may more satisfactorily account for the phenomenon, as I do not consider it at all necessary that the said satellites should be a few thousands, or even a few hundreds, in number.

The remaining satellites of Jupiter, Barnard's included, are surely unable to sensibly annul the effect of the hypothetical satellites, as I shall show in another more extensive article. In order, therefore, to account for the equatorial current, it is by no means necessary that the action of the hypothetical satellites should be superior to that of the others.

As to the relation between Jupiter and the sun, it appears to me that it is not very clear.

The variation in the time of rotation of the solar photosphere is a continuous function of the heliographic latitude. With Jupiter there takes place nothing of the kind. Under the equatorial current and, consequently, at the same latitude appear the edges of the equatorial belts, which take about five minutes more to turn; on the other hand, there are belts and spots in high latitudes which turn more rapidly than the equatorial belts and the Red Spot.

I look upon it as certain that the equatorial current, so different in its motion from all the other markings of Jupiter, is impulsed by a force exterior to the planet, this force proceeding, in all probability, from one or more invisible satellites.

I shall presently take up this question in all its details, having only lightly touched upon it in my first paper.

J. COMAS SOLÀ.

Astronomical Publications.

The Sun.—M. Guillaume continues his observations of solar activity in the third quarter of 1899. The number of spots was unaltered (16), but their total area was much decreased, being 499 millionths instead of 1,096. They still were divided in the proportion 10 spots to the southern hemisphere and six to the northern. No spots were visible on 35 days. The number of groups of faculæ increased, being 42 instead of 27 in the preceding quarter, but the total area diminished from 30·9 thousandths to 29·0. Small faculæ were perceived in the high latitudes of + 70° and +-76°.

Daily Register of the Sun's Chromosphere at Meudon Observatory.—To continue his chromospheric work, begun at the Paris Observatory, at Meudon, the French Academy have given a subvention to M. Deslandres. At Meudon, M. Deslandres has confined his work to that with a "spectrographic des formes" which he describes, and of which he gives a diagram (C.R., December 26, 1899). His photographs for 1899 are of special interest, since the sun is very near its minimum activity. Those taken in 1892 and 1893 were at a time when the spots were at a maximum. The later photographs show that the "reseau chromospherique," which was seen to cover the whole solar disk in 1893, is a *permanent* feature of the sun's surface, even up to the solar poles, when no spots are visible. It is also *persistent* in the sense that it retains the same form for hours at a time. It often appears to be made of meshes which, however, were less numerous in 1898, but this diminution was not confirmed by the photographs of 1899, which are nearer the minimum. (C.R, No. 26, 1899, December 26.)

Green and Red Rays. *M. V. Turquan* was enabled to observe not only the green ray, accompanying sunrises and sunsets, but also the *red* ray. (B.A.F., October 1899.)

To Photograph the Solar Corona in 1900. *W. W. Payne.*—Mr. Burckhalter, Director of the Chabot Observatory, Oakland, Cal., hopes to photograph the corona with a revolving diaphragm before the sensitive plate, which will vary the times of exposure for different parts from $0^s{\cdot}2$ to 10^s, and so record the details of both bright and faint parts upon the same plate. Prof. W. H. Pickering will study the brightness of the sky, and make a photographic search for intra-mercurial planets. He is reasonably sure that a body 20 miles in diameter within 15,000,000 miles of the sun would be recorded. (P.A., December.)

Relation between Magnetic Disturbance and Sun-spot Frequency. *W. Ellis.*—As the result of laborious examination of photographic registers of magnetic disturbances during 50 years, Mr. Ellis finds that on most days magnetic disturbance superposed on the diurnal movement exists to a greater or lesser extent. Whether days of quiet magnetism are considered, or days of

disturbance (not extreme) the diurnal range is found to vary both in period and magnitude in close accordance with the variation of sun-spot frequency. While magnetic phenomena are more marked in some periods than others, it is found that those of diurnal variation and disturbance vary independently with the variation of sun-spot frequency. Further there is an annual inequality independent of sun-spot frequency having maxima at the equinoxes and minima at solstices. (**M.N.**, December.)

THE LUNAR ECLIPSE OF 1898 DECEMBER 16.—M. Montaugeraud exposed 12 plates at Toulouse Observatory on different phases of the lunar eclipse of December 16. The exposures were various and the plates were slow, rapid and panchromatic. Comparing these plates with those obtained during the total eclipse of 1898, December 27, it is found that they are superior in the amount of the eclipsed surface photographed. The eclipse of 1898 was remarkable in that during totality a considerable portion of the disk was more sensibly brighter than the rest, and this contrast is apparent on the plates, whilst in the eclipse of December last the light was nearly uniform within the cone of shadow. In the earlier eclipse only a part of the eclipse portion appeared on the plates; in the eclipse of 1899 the whole was traceable (**C.R.**, No. 26, 1899, Dec. 22) for occultations by M. André, of Lyons Observatory, *see* **C.R.**, No. 1, 1900, January 2, and by M. Chofardet, at Besancon, **C.R.**, No. 2, 1900, January 8.)

THE SATELLITES OF JUPITER. *L. Rudaux.*—Here is another case of over-refined, if not imaginary, observations. M. Rudaux considers himself entitled to fix the dimensions of these globes with an accuracy of 5 kilomètres (3·1 miles), when the separating power of his telescope (95^{mm} = 3·740 inches) *scarcely exceeds the diameter itself of these bodies*! And yet his paper occupies 12 pages of the "Bulletin de la Société Astronomique de France," for September 1899.

METEORS.—Observations of the Leonids are given by Benko, Weiss, Bidschof, Riggenbach, in **A.N.**, No. 3,612, by Oertel, Gautier, Witt, Stratanoff, Ricco, Ambronn, Knopf, Charlier, Fenyi, in **A.N.**, No. 3,613, and by Thome, Laska, and at Kalocsa Observatory in **A.N.**, No. 3,614.

The Perseids are observed by Benko, in **A.N.**, No. 3,612, and the Bielids by Bidschof, in **A.N.**, 3,612, and by Oertel in **A.N.**, No. 3,613.

CONTEMPORARY METEOR SHOWERS OF THE LEONID AND BIELID METEOR PERIODS. *A. S. Herschel.*—In a series of watches lasting 12½ hours between November 6 and 16, Prof. Herschel saw five Leonids and 69 non-Leonids, but between $1^h\ 15^m$ and $6^h\ 15^m$ a.m. on November 15, Sir W. J. Herschel and a party of watchers recorded 62 Leonids and 40 non-Leonids, whilst six or eight came too rapidly to be charted. One of the non-Leonids, which appeared at $5^h\ 40^m$, was brighter than Sirius, described a path from *α Ursæ Majoris* to *α Camelopardis*, and left a streak, part of which was visible for five minutes. From

comparison with observations made at Yeovil and Woburn, Mr. Denning has fixed the radiant at $193^\circ + 27^\circ$. The only distinctly active radiant near the sickle of the Leo was that near κ Leonis, but five other co-Leonid centres were all well marked, and a table of 37 meteors from these radiants gives particulars of the observations. Most of the ordinary meteors were slow moving.

Thirty Bielids and 188 ordinary shooting stars have been mapped between November 20th and 30th, during the years 1861-97. These do not include any maximum appearance of the Bielids, which accounts for the fact that they form only 16 per cent. of the non-Bielids, whilst the shower from ϵ Tauri gave 12 per cent. This latter shower, with which the η Taurids are possibly associated, shows a yearly stability approaching that of the August Perseids, though of much smaller numerical strength. It also produces a number of large meteors and detonating fire-balls. Six other showers furnish an average of 4 per cent. for each shower, and 11 more an average of 2 per cent. of the ordinary meteors recorded. A good deal of information is given as to the general appearances of these showers and the years in which they have been noted.

Dr. Bredichin has shown that the node of the Bielid stream was shifted 4° backwards by the action of Jupiter in 1890, and Dr. Abelmann that it will be again shifted 6° in 1901. The next expected great return will be on November 17, 1894 or 1895. (**Nat.**, January 4, 18.)

A BRILLIANT METEOR IN SUNSHINE.—A brilliant meteor was seen from the S.E. of England about 2.55 p.m. on January 9, the sun shining at the time in a cloudless sky. The motion was from W. to E., and the path terminated as seen from Surrey and Kent, a little under the moon, which was then E. by S. at an altitude 33°. The writer quotes a number of descriptions taken from various sources, from which he has computed the following provisional real path.

Meteor began, 59 miles above a point 10 miles E. of Valognes, near Cherbourg.

Meteor ended, 23 miles above Calais.

Length of path, 175 miles.

Radiant, $280^\circ - 12^\circ$.

It is hoped that observations may have been made in France, which will enable the elements to be more certainly determined. (**Nat.**, January 25.)

THE ANDROMEDES.—Prof. Brenke, at Illinois, assisted by two students, observed on the night of November 24, from $8^h\ 9^m$, 90th meridian time, to $11^h\ 4^m$, and counted 116 Andromedes, but the later observations were interfered with by clouds. The greatest hourly number was during the first 14 minutes, when they were counted at the rate of 110 per hour, the density falling off very rapidly after this. A diffuse radiant was found at 2° from γ Andromedæ on the line towards α Cassiopeiæ.

At Northfield, observations were commenced at 10 p.m. on the same evening, and in the first five minutes one observer counted 10 Andromedes. After this they came more slowly, and clouds

soon covered the sky, but it cleared again at 11 o'clock, by which time the shower was nearly over. None were seen on the 25th. The radiant was placed about one-third of the way from γ towards ϕ Andromedæ.

At Boston, 64 were seen between 7^h and $10^h 2^m$ by R. M. Dole, most of them fairly bright, and two of magnitude 0. Eleven Taurids were seen, and two sporadic meteors. (P.A., January.)

The Leonids.—At Northfield, 20 members of Carleton College observed 26 Leonids between 17^h and 22^h G.M.T., on Nov. 15. The sky was never entirely clear, and the observations are regarded as unsatisfactory.

At Barre Center, N.Y., 19 were charted by W. Wetherbee between 1 a.m. and 4 a.m. on the morning of November 15. At 1.30 a.m. a brilliant slow moving meteor was seen travelling eastwards from Ursa Major. The watch was continued without result on the 16th and 17th.

At Boswell Observatory, Crete, Neb., Prof. H. H. Horsford and a party of students observed 198 meteors on the night of November 14, of which 53 were platted; of the latter, six were certainly not Leonids, and six were doubtful. A considerable increase in the hourly number appears after 17^h, when the moon set. On November 16, 30 were counted between 15^h and $18^h 30^m$, two of which were not Leonids.

At Chamberlin Observatory, Colorado, Prof. H. A. Howe observed 13 Leonids on the night of November 13, 15 on November 14, none on November 16, two on November 17. On November 15 he was assisted by a corps of volunteer observers, when about 150 were counted, one pair of observers seeing 64. Few were seen before 14^h on any night, and those facing south-east saw the greatest number. For a week prior to November 13, the number of telescopic meteors seen in the 20-in. refractor with a field of $15'$ was about three in every four hours, at least three times the ordinary frequency.

At Lisbon, Portugal, watches were kept from November 12 to November 17. Ten were observed on November 14, 11 on November 15, 7 on November 17. The 12th and 17th were the only nights quite free from clouds. (P.A., January.)

A Possible Explanation of the Gegenschein. *W. H. Pickering.*—There must necessarily be a large number of small bodies accompanying the earth as satellites. Those which move in planes near the ecliptic must in consequence of tidal friction recede from the earth until at a distance something over one million miles, their periods become exactly one year. Beyond this point they become dependent upon the sun, but as the rate of recession becomes slower near the limiting distance, there must be a large proportion with this period. The effect of solar perturbations will cause a condensation of these on the side of the earth away from the sun, and nearly in the line joining the sun to the earth, and as in this position they are full to the earth part at least of the Gegenschein must be due to this cause. The only question is whether it is sufficient to account for the whole. If this hypothesis is correct, the action of the moon will displace the

Gegenschein to the west at full moon, to the east at new moon. In **P.A.**, for 1897, Vol. V., p. 178, Mr. Douglas describes observations which show an effect of this kind. (**P.A.**, January.)

PERIODICAL COMETS DUE IN 1900. *W. T. Lynn.*—With the exception of Finlay's Comet, which may possibly reappear in January, the only comet expected to return this year is the small one discovered by Prof. Barnard at the Lick Observatory in 1884. The period was determined to be about 5½ years, but it escaped observation both in 1889 and 1895. The next return will be due towards the end of 1900. (**Obs.**, January.)

THE RING NEBULA IN LYRA.—At the Toulouse Observatory, M. Stratonoff has observed the central star both visually and photographically, and confirms its variability. He also finds that, photographically estimated, the magnitude of the star appears to decrease with the length of exposure, which he explains by the supposition that the central star, being a condensation of the nebulous matter, gives on the plates an image which increases in intensity more slowly than a star properly so called. He also concludes that the contours of the star are irregular and filamentary (**A.N.**, No. 3607). Herr Leo Brenner gives observations of stars visible in the ring nebula. (**A.N.**, No., 3614.)

PHOTOGRAPHS OF NEBULÆ. *L. Rabourdin.*—The author was allowed to utilize the great reflector of the Meudon Observatory, whose aperture is one metre (39⅜-ins.) and whose focal length measures 3 metres (118⅛-in.). The result is a beautiful series of negatives of the horse-shoe, or ω Nebula in Scutum Sobieski, and of the great cluster 13M Herculis. (**B.A.F.**, July 1899.)

PHOTOGRAPH OF THE TRIFID NEBULA ♅ IV 41 SAGITTARII AND THE REGION SURROUNDING. *Isaac Roberts.*—Taken with the 20-inch reflector, with an exposure of 90 minutes. The nebula is characterised by tortuous dark rifts without stars in them. Those intersecting the denser part of the nebulosity have sharply defined margins, while those traversing the fainter parts are broader, and include some nebulosity. The inferences we may reasonably draw from these appearances are that the nebulæ are developing into the more stable form of stars under the influence of gravitation. They appear to be the earlier stages in the development of spiral nebula. Most useful work would the careful measurement of the position angles and distances of sufficiently well defined star-like condensations in various nebulæ from selected normal stars. In this way any changes in these bodies would be demonstrable. (**Kn.**, February 1900.)

NEW NEBULÆ DISCOVERED PHOTOGRAPHICALLY. *J. E. Keeler.*—With exposures of four hours the Crossley photographs show stars and nebulæ far beyond the range of any visual telescope. On the assumption that there are three new nebulæ for each square degree, the number in the whole sky would be about 120,000. Though there are large regions where few new nebulæ are found, Dr. Keeler regards the above estimate as below the truth. On many plates covering one square degree from

20 to 30 new nebulæ or nebulous stars were found. It is remarkable and significant that most of the nebulæ photographed seem to be spiral. (M.N., December.)

SOUTHERN DOUBLE STARS. *T. Lewis.*—Double-star work in the southern hemisphere has always been of a most desultory kind, something being urgently needed to place the work on a proper footing, something that would enable workers to conserve their energy for use on certain systems, and provide the knowledge that their work was of real value. This want has been supplied by the "Reference Catalogue of Southern Double Stars" recently issued from the Cape Observatory. The author, Mr. R. T. A. Innes, joined the staff of the observatory in 1896 as secretary, librarian, and accountant. It formed no part of his official duties to engage in astronomical observing, or to contribute to the publications of the Cape Observatory. Within the last two years, in the intervals of his leisure time, he has not only completed this catalogue, but has also discovered upwards of 280 new double stars with the 7-in. equatorial.

Mr. Innes states that "in spite of neglect, the southern systems "already exceed in importance those of the north," but this is certainly premature. So far as things are at present, the great bulk of knowledge naturally rests with the northern systems, and the number of known northern binaries largely exceeds those of the south. (Obs., January.)

THE METHODS OF INORGANIC EVOLUTION, I. *Sir N. Lockyer.* —Does the dissociation of a chemical element break it up into constituents which resemble one another, or which differ from one another? If an element, as magnesium, is dissociated, the constituents will have lower atomic weights than magnesium. This may explain the fact that lines in the high temperature spectra of magnesium (weight 24) and calcium (40) appear before those of oxygen (16). If two depolymerisations take place in calcium and one in magnesium, we should have proto-calcium (weight 10), proto-magnesium (12), oxygen (16). The phenomena presented by "series" in spectra are explained by supposing that the substances producing the subordinate series can be broken up by heat, whilst that producing the principal series cannot. Oxygen at low temperature gives a fluted spectrum; a low pressure induced current breaks this up into two principal series, each having two subordinates. This cannot be due to simple depolymerisation, because the two constituents are not alike; it may be may be explained by supposing six depolymerisations. But a stronger induced current gives a new spectrum with a greater number of lines. We have no knowledge of their arrangement in series, but their number suggests that they may be due to four additional sets of three series, which would require 12 more depolymerisations. Similar considerations applied to hydrogen show that the line spectra observed in stars must be due to a substance of atomic weight ·0019), but from the investigations of Prof. J. J. Thomson we are learning something about such small masses, and this may favour the view that polymerisation is a *vera causa* for molecular complexity. (Nat., December 7).

ASTRONOMY AND ASTROLOGY. A QUESTION OF PRIMOGENITURE. *E. Walter Maunder.*—In the absence of any knowledge of the circumstances in which the science of astronomy had its beginning, we can but make a guess as to its origin, and most of our leading writers agree as to the agent which gave it birth. Astronomy, say they, is the daughter of astrology. In the view of the writer, however, astrology, so far from being the parent of astronomy, must be looked upon as a late and most degenerate descendant of the sublime science. A consideration of the knowledge involved in the exercise of the astrological art shows that the constellations had been devised and mapped out; that the planets were recognised as such, and that a knowledge of how to predict their places with considerable precision had been attained. This means a mastery of the apparent movements of the planets which can only have been obtained after centuries of the closest observation. In other words the existence of astrology presupposes a state of astronomy not less advanced that it was in Alexandria under Claudius Ptolemy, and at Samarkand under Ulugh Beigh. As regards the period when astrology as a complete system first arose there are strong grounds for thinking that it must have been many centuries later than 1800 B.C. (**Kn.**, February 1900.)

THE NEW PHOTOGRAPHIC TELESCOPE OF THE POTSDAM ASTROPHYSICAL OBSERVATORY.—This is now in position, and an excellent photograph is given. It consists of a photographic telescope of 80 cm. (31·5 in.), and a visual of 50 cm. (19·7 in.). They have approximately equal focal lengths, and are mounted on the same declination axis, both on the same side of the polar axis. No description accompanies the photograph. (**P.A.**, January.)

THE ASTRONOMICAL DIRECTOR OF THE UNITED STATES OBSERVATORY.—Prof. William Harkness retired on December 17, under the superannuation rule. He has been associated with Profs. Hall, Frisby, and Eastman, and by their joint labours, the Observatory, which was little more than a chart depôt, with the instruments necessary for rating chronometers and making such observations as were required for the American ephemeris, has been raised to its present position. Prof. Harkness was born in Scotland, December 17, 1837, but emigrated to America with his father when a mere child. He enlisted as a surgeon in the Federal Army in 1862, but was appointed an aid in the Naval Observatory in 1863, and Professor of Mathematics the same year. During the eclipse of 1869, he discovered the "1874" corona line (this was also seen and measured during the same eclipse by Prof. Young). In 1871, he was attached to the Transit of Venus Commission, and designed the instruments used; in 1882, he was made executive officer, and reduced the photographic work. In 1890, he was appointed Astronomical Director of the Observatory, and in 1897 he succeeded Prof. Newcomb as head of the "Nautical Almanac." He invented the sphereometer caliper for measuring inequalities of pivots, whilst his "Solar Parallax and its related Constants," is one of his most important memoirs. He will continue his scientific work in Washington. Prof. S. J. Brown has

been appointed to succeed him at the Observatory. (**Nat.**, January 11; **P.A.**, January.)

THE THEORY OF THE FIGURE OF THE EARTH. *G. H. Darwin.*—The space in the neighbourhood of an oblate ellipsoid of revolution may be divided into three regions by two spheres touching it internally and externally, and it is possible to express the potential of a solid ellipsoid by series of spherical harmonics which are convergent; the convergency for the included space being uncertain. This method, however, is not justifiable when the development is carried to the squares of small quantities. If having found our two series expressive of the potential for internal and external space respectively we determine the form of the surface inside the middle region at which these two potentials are continuous, as far as the second order of small quantities we find the surface in question is that of the ellipsoid itself. There is, however, another method of finding the potential of the ellipsoid by which the difficulty as to convergency is avoided. Prof. Darwin has contributed a mathematical investigation dealing with this at great length. (**M.N.**, December.)

ASTRONOMY WITHOUT A TELESCOPE.—I. *E. Walter Maunder.* —In this paper, which is introductory to a series to be published under this title, it is pointed out that there are four fields in which extremely useful work can be done without instrumental aid, work for which the unaided eye is the ideal instrument. These are the study of the Milky Way, the Zodiacal Light, and the Gegenschein and Auroræ, fields full of interest, and by no means too fully cultivated. With the modest equipment of an opera glass these observations may be extended to include variable stars. (**Kn.**, January 1900.)

UNITED STATES NAVAL OBSERVATORY.—Capt. Davis' report for the year ending 1899, June 30, states that the 26-in. refractor has been used for spectrographic determinations of velocity in the line of sight. Difficulties due to the O.G. being corrected for visual use have been overcome by the introduction of a correcting lens of 2·09 ins. aperture, and the probable error in velocity, as determined from a single plate is 0·71 mile per second. Measures of the diameters of Mercury and Venus show that the irradiation is a function of the magnifying power. The 40-foot heliograph was installed 1898, October 11, and negatives have been taken on 122 days. The diameter of the sun's disk is 4·3 ins. The 12-in. equatorial has been used for observations of minor planets, comets, occultations, &c., all of which have been reduced and published. Transit observations have been made continuously. The new 5-in. altazimuth, and the prime vertical instrument have been used for determining variation of latitude, and the constants of aberration and nutation. In the ephemeris for 1903 the apparent diameter of the sun is to be changed from 960″·78 to 961″·50, the new value being derived from the discussion of 35,482 meridian observations made at the principal observatories of the world. (**Nat.**, February 1.)

Notices of the Association.

The ordinary Meetings of the Association will be held on February 28, March 28, April 25, May 30, and June 27.

Editorial Change of Address.

The Editor asks Members to kindly note that his address in future will be—

Mr. E. WALTER MAUNDER, F.R.A.S.,
86, Tyrwhitt Road, S.E.

Queries.

It is requested that queries be written on one side of the paper only, and each query on a separate sheet.

Queries may either be placed in the Query Box at the Meeting, or may be sent to the Hon. Secretary, Mr. W. Schooling, F.R.A.S., Fairholme, Christchurch Road, Surbiton.

Errata in "Journal," Vol. X., No. 3.

Owing to proofs having been delayed in their return to the Editor, the following errors require correction in the last Number of the "Journal":—

Page 122, line 18, *for* their *read* these.
Page 122, line 40, *for* there *read* these.
Page 111, line 5, *for* ζ Tauri *read* τ Tauri.
Page 111, line 17, *for* H 250°·3 *read* H 256°·3.
Page 111, line 36, *for* observation *read* observations.
Page 111, line 46, *for* 25 Canis Ven. *read* 25 Canum Ven.
Page 111, line 47, *for* β Dephini *read* β Delphini.
Page 111, line 49, *for* θ Draconis *read* o Draconis.
Page 111, line 53, *for* 5″ *read* 5 inches.
Page 111, line 53, *insert* full stop after seen.
Page 111, line 54, *for* elong. *read* elongates.
Page 129, line 5, for ξ Ursæ Major *read* ξ Ursæ Majoris.
Page 129, line 5, *for* Mr. Jeffrey *read* John Jeffrey.
Page 129, line 9, *for* Hillend Gardens, Partick Hill, *read* 154, Nithdsdale Road, Pollokshields.
Page 113, line 40, *for* (4511) S Ursæ Majoris *read* (4557) S Ursæ Majoris.

Additions to the Library.

Dr. Roberts.—Photographs of Stars, Star Clusters, and Nebulæ, Vol. II.
Antoniadi.—Further Notes on Saturn's Crape Ring.
—— Le maximum des taches solaires en 1898.
Astronomische Nachrichten, Band CL.
—— Rundschau, Band I.

British Astronomical Association, Journal Vol. IX.
—— Memoirs, Vol. VII.
Royal Astronomical Society, Monthly Notices, Vol. LIX.
Schiaparelli.—Osservazioni di Marte, Memoria 5.
Leeds Astronomical Society.— Journal and Transactions, 1898.
Société belge d'Astronomic, Bulletin, Tome IV.
—— Astronomique de France, Bulletin, Tome XIII.
Popular Astronomy, Vol. VII.
Vereinigung von Freunden der Astronomie, Mitteilungen, Band IX.
Observatory, Vol. XXII.
Royal Institution, Proceedings, Vol. XV.
United States Naval Observatory. Report of the Superintendent, 1899.
—— —— of the Board of Visitors, 1899.
Observatoire royal de Belgique, Annuaire, 1900.
American Philosophical Society Transactions, Vol. XX., i.
Perth (Western Australia) Observatory.— Meteorological Observations, 1898.

Candidates for Election as Members of the Association.

28TH FEBRUARY 1900.

ARTHUR C. BANFIELD,
Teme Street, Tenbury, Worcestershire.
Proposer—E. Walter Maunder. *Seconder*—A. S. D. Maunder.

REV. W. H. BROWNE,
Durham University.
Proposer—J. Stark Browne. *Seconder*—Thos. Frid Maunder.

CAPT. ALFRED CARPENTER, R.N., F.R.MET.SOC.,
The Red House, Sanderstead, Croydon.
Proposer—H. Keatley Moore. *Seconder*—Carlton J. Lambert.

MRS. ANDREW CROMMELIN,
Benvenue, 55, Ulundi Road, Blackheath, S.E.
Proposer—A. S. D. Maunder. *Seconder*—W. H. Maw.

THOMAS WILLIAM FOINETTE, ASSOC.I.ELEC.ENG.
305, High Road, Lee, S.E.
Proposer—Robert Killip. *Seconder*—E. Walter Maunder.

WALTER HEATH, M.A.,
Redcot, Cobham, Surrey.
Proposer—George Heath. *Seconder*—William Chamberlain.

RICHARD JACQUES, M.I.C.E.,
"The Athelstane," Manchester Road, Buxton.
Proposer—Henry Bath. *Seconder*—Thos. Frid Maunder.

MISS JUDITH LOUISE LEARMOUTH,
The Cottage, Northaw, Potters Bar.
Proposer—Thomas Snow. *Seconder*—William Royle.

REV. CHARLES J. STEWARD, F.R.MET.SOC.,
The Cedars, Anglesea Road, Ipswich.
Proposer—Rowland V. Barker. *Seconder*—Lucas T. Cobbold

WILLIAM ROBINSON,
Balliol House, Wentworth Street, E.
Proposer—John Bullock. *Seconder*—Thos. Frid Maunder.

CAPT. CHARLES RICHARD STEVENS, R.E.,
Grange Cottage, Netley Abbey, Southampton.
Proposer—D. A. Pennington, Col. *Seconder*—J. G. Petrie.

New Members of the Association.

ELECTED 31ST JANUARY 1900.

GAVIN JAMES BURNS, B SC., Kendal House, Holland Road, Weymouth.

WILLIAM BRAYTON DODD, Newtown, Whitehaven.

WILLIAM SAUNDERS EDWARDS, Thornleigh, Bradpole, Bridport.

MISS ALICE EVERETT, M.A., 11, Leopold Road, Ealing Common, W.

R. COWARD JOHNSON, F.R.A.S., 7, Sweeting Street, Liverpool.

JOHN MCLENNAN, Harbour Cottage, Dingwall, N.B.

ERNEST RABONE, 35, Avenue Road, Highgate, N.

North-Western Branch.

NEW MEMBER OF THE ASSOCIATION.

Elected, 6th December 1899.

CHARLES L. MAKINSON, Grove Terrace, Higher Broughton, Manchester.

West of Scotland Branch.

NEW MEMBERS OF THE ASSOCIATION.

Elected 19th January 1900.

DAVID KAY, 6, Witch Road, Kilmarnock, N.B.
A. WILSON SMART, 66, Bath Street, Glasgow.

East of Scotland Branch.

NEW MEMBER OF THE ASSOCIATION.

Elected 20th January 1900.

R. C. MOSSMAN, F.R.S.E., 10, Blacket Place, Edinburgh.

Queries.

Query No. 61. THE MOON'S TERMINATOR.—What is the moon's "terminator," and of what use is it that its position should be known at any particular hour?

Reply.—The moon's "terminator" is the line dividing the illumined part of the moon's sphere from the unillumined portion. This line slowly moves across the moon's disk from W. to E., occupying approximately 14 days in so doing, *i.e.*, from new to full moon. The knowledge of the position of the terminator on any given day or hour is of immense value in enabling us to discover the angle of illumination under which drawings of the moon's surface were made, it may be, years ago, and also in enabling us to predict when similar conditions of illumination will be found in the future.

Query No. 62. STANDARD SCREWS.—What is the diameter of the standard screw for eye-pieces, and how many threads to the inch? Is there a standard screw for sun caps?

Reply.—There is no standard screw for either eye-pieces or sun-caps.

Query No. 63. OCCULTATIONS.—I want to get particulars of occultations observed on or about 14th and 15th August 1899. Can you tell me of any observatory where it is likely I might obtain such information?

Reply.—No occultations were observed at the Royal Observatory, Greenwich, on the dates mentioned. The querist might apply to the Directors of the Dublin (Dunsink), Edinburgh (Blackfoot Hill), or Oxford (Radcliffe) Observatories.

Query No. 64. URSÆ MAJOR, ORION, AND THE SOUTHERN CROSS.—The following statement appeared in "The Hospital" for February 3, 1900, by a nurse in Syria, near Mount Carmel, "As night wore on I stole out on to "the verandah to watch the glorious eastern sky. Never before have I seen "stars so thick and brilliant, and I wished I had known the names of many. "As it was, I was able to distinguish Orion's belt, the Great Bear, and also "the Southern Cross. In front of the house flowed the Mediterranean; "blue as a sapphire by day, but dark and stormy at night." Would it be possible to see these three constellations at the same time at any place?

Reply.—It would be perfectly possible to see all three constellations at the same time from a station within the tropics; but not from Mount Carmel. The Southern Cross is not visible from Mount Carmel at any time.

Notes.

ROYAL ASTRONOMICAL SOCIETY. — The Society met in Burlington House on Friday, January 12, Prof. G. H. Darwin, *President*, in the Chair. The *Secretary* read the list of presents received, which included Dr. Ambronn's work on astronomical instruments; Dr. Roberts second volume of stars, star clusters and nebulæ; and 19 charts of the Paris astrographic plates. *Mr. S. A. Saunder* read a paper on Determination of Selenographical Positions and the Measurement of

Lunar Photographs, calling attention to the uncertainty in our knowledge of the positions of lunar formations, and suggesting methods for finding them more accurately. He pointed out that such lunar photographs as those taken at Paris by M. Loewy were of the utmost value in determining with accuracy the positions of the lunar features. He also proposed the preparation of such a map of the moon as was suggested some 30 years ago by the Lunar Committee of the British Association. The *President, Prof. Turner, Mr. Crommelin,* and *Dr. Rambaut,* joined in the discussion which followed. *Mr. Wesley* then showed a photograph of the nebula H. V. 14, taken by Mr. W. E. Wilson, of Daramona, Streete, with an exposure of 1½ hours on a Cadett plate, and *Mr. Dyson* showed a photograph of the Pleiades taken at the Royal Observatory, Greenwich. *Prof. Turner* and the *Astronomer Royal* discussed the method of mounting and guiding the reflector with which the photograph was taken, and the *President* then called on *Prof. E. E. Barnard* to speak, who drew attention to the small amount of nebulosity round the bright stars, and *Dr. Common* and the *Astronomer Royal* discussed the presence of rays in the brighter stars, due to the supports of the flat. *Dr. Rambaut* read a paper on the unpublished observations made with the transit instrument and quadrants at the Radcliffe Observatory between the years 1774 and 1838, and the Meeting then adjourned.

North-Western Branch (Manchester).*—The Fourth Meeting was held on January 3, when, the President being still indisposed, the chair was occupied by Mr. Thomas Thorp.

Following the interval devoted to conversation, a report was read from Mr. C. A. Binyon, Evesham, on the partial Lunar Eclipse of December 16–17, which he had successfully observed. The Rev. R. Killip also read a minute account of the same phenomenon, as observed by him, at St. Anne's-on-the-Sea, and remarks were contributed by other Members. A paper entitled "Astronomers and their Telescopes," kindly contributed by Mr. W. Forgan, Edinburgh, and illustrated by over 90 lantern slides, was also read by the Secretary, and the thanks of the Meeting were expressed to Mr. Forgan for the paper, and the use of the slides illustrating it.

At the Annual Meeting of the Society, held on February 9, 1900, in the Society's Rooms, Burlington House, the following Fellows were elected as Officers and Council for the ensuing year:—

President, Mr. E. B. Knobel; *Vice-Presidents,* Sir R. S. Ball, Dr. Common, Prof. Darwin, Prof. Turner; *Secretaries,* Mr. Dyson and Mr. Newall; *Treasurer,* Mr. Maw; *Foreign Secretary,* Sir W. Huggins; *Council,* Mr. Christie, Dr. Downing, Mr. Glaisher, Capt. Hills, Mr. McClean, Major MacMahon, Capt. Noble, Dr. Rambaut, Mr. Seabroke, Mr. Spitta, Mr. Thackeray, and Mr. Whittaker.

The retiring President, *Prof. G. H. Darwin,* delivered an address on the presentation of the gold medal of the Society to M. Henri Poincaré for his researches in Celestial Mechanics.

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* Received too late for insertion in the usual place.

The Meeting then proceeded to consider a proposed addition to Byelaw 24, having the effect of empowering the Council, in the case of the resignation of a Fellow in arrears with his subscription, to omit those arrears under certain conditions. This alteration was adopted. A further alteration of the byelaws involving a change in the hour for the ordinary meetings from 8 p.m. to 5 p.m. was discussed, but was not adopted.

PRIZES OF THE FRENCH ACADEMY OF SCIENCE.—The French Academy have awarded the prix Lalande to W. R. Brooks for his cometary discoveries; the prix Valz to M. Nyrén of the Pulkova Observatory, for his astronomical researches; and the Arago medal to Sir G. G. Stokes, of Cambridge University.

COMET NOTES.—A new comet (a 1900) was discovered by M. Giacobini at Nice on January 31. The following observations have been received:—

Nice M.T.	R.A.	S. Dec.
d h m	h m s	° ′ ″
Jan. 31 7 30	2 57 44	7 55 0
Feb. 3 7 25·8	2 49 51·0	6 40 10

Deduced daily motion $-2^m 38^s$, N. 25′.

The comet is very faint, being only of the 13th magnitude. Moonlight has probably prevented later observations. No orbit is yet to hand.

A.N. 3614 contains definitive elements of Comet 1897 III. (Perrine) by E. Wessell. The comet was only under observation from 1897 October 16, to November 27. It was very ill-defined, without a nucleus, so that the observations are not in good agreement with one another, and the elements cannot be determined with great precision. The following is the orbit deduced:—

$$T = 1897 \text{ December } 8{\cdot}67979 \text{ Berlin M.T.}$$
$$\left.\begin{array}{l} \omega = 65^\circ\ 53'\ 58'' \\ \Omega = 32\ \ \ 3\ \ \ 9 \\ i = 69\ \ 35\ \ 58 \end{array}\right\} 1897{\cdot}0$$
$$\log q = 0{\cdot}132477$$

A.N., 3611, gives a series of observations of Tuttle's comet (1899 III.) made at the Lick Observatory by Mr. Perrine. On March 9 it was of magnitude 11½, with a nucleus of 16th magnitude. On April 11 it was of the 10th magnitude, 2′ in diameter, with a 12th-magnitude nucleus. The latest observation was on May 1.

In the same publication there is a long series of observations of Wolf's Periodic Comet, 1898 IV., made by Prof. Hussey, the dates ranging from 1898 June 16 to 1899 March 10.

Tempel's Comet, 1899 IV., was observed on the meridian at the Cape Observatory on 20 nights, ranging from 1899 July 11 to September 9. (**A.N.**, 3612.)

A.N., 3618 also contains a fine series of observations of this comet, made at Cordoba (Argentine Republic) by Mr. James

Renton, the dates ranging from 1899 July 11 to October 11. A very large number of observations of this comet at the recent apparition was obtained at various observatories, and it is hoped that when reduced and discussed they will supply material for improving our knowledge of the mass of Jupiter.

Variable Stars.—*S Bootis* passed a minimum of $13{\cdot}0^{m}$ on November 20, 1899; $m - m = 292^{d}$. (E.M., 580.)

R Draconis passed a minimum of $13{\cdot}3^{m}$ on November 26; $m - m = 272^{d}$. (E.M., 469.)

R Lyncis showed a minimum of $13{\cdot}0^{m}$ on January 10; $m - m = 359^{d}$. (E.M., 580.)

U Orionis passed a minimum of $11{\cdot}3^{m}$ on November 26; $m - m = 373^{d}$. (E.M., 469.)

S Ursæ Majoris passed a minimum of $12{\cdot}2^{m}$ on October 30; $m - m = 206^{d}$. (E.M., 469).

T Ursæ Majoris probably passed a minimum of $13{\cdot}0^{m}$ on November 15; $m - m = 245^{d}$. (E.M., 580.)

Minima of the Variable Stars of the Algol Type.
(Given to the nearest hour G.M.T.)
(P.A., 44.)

Algol.

	d	h
Feb.	7	17
„	10	14
„	13	11
„	16	8

U Cephei.

	d	h
Feb.	1	7
„	3	19
„	6	7
„	8	19
„	11	6
„	13	18
„	16	6
„	18	18
„	21	6
„	23	18
„	26	5
„	28	17

S Velorum.

	d	h
Feb.	5	18
„	11	17
„	17	15
„	23	14

λ Tauri.

	d	h
Feb.	8	13
„	12	12
„	16	10
„	20	9
„	24	8
„	28	7

R Canis Majoris.
Every 8th Min.
$P = 1^{d}\,3^{h}{\cdot}3$

	d	h
Feb.	6	1
„	15	4
„	24	6

δ Libræ.

	d	h
Feb.	4	17
„	11	17
„	18	17
„	25	16
„	28	0

U Coronæ.

	d	h
Feb.	1	19
„	8	17
„	15	15
„	22	13
„	26	0

RS Sagittarii.

	d	h
Feb.	0	16
„	5	12
„	7	22
„	12	18
„	17	14
„	24	20

DM + 45° 3062.

	d	h
Feb.	1	6
„	5	20
„	10	10
„	14	23
„	19	13
„	24	3
„	28	17

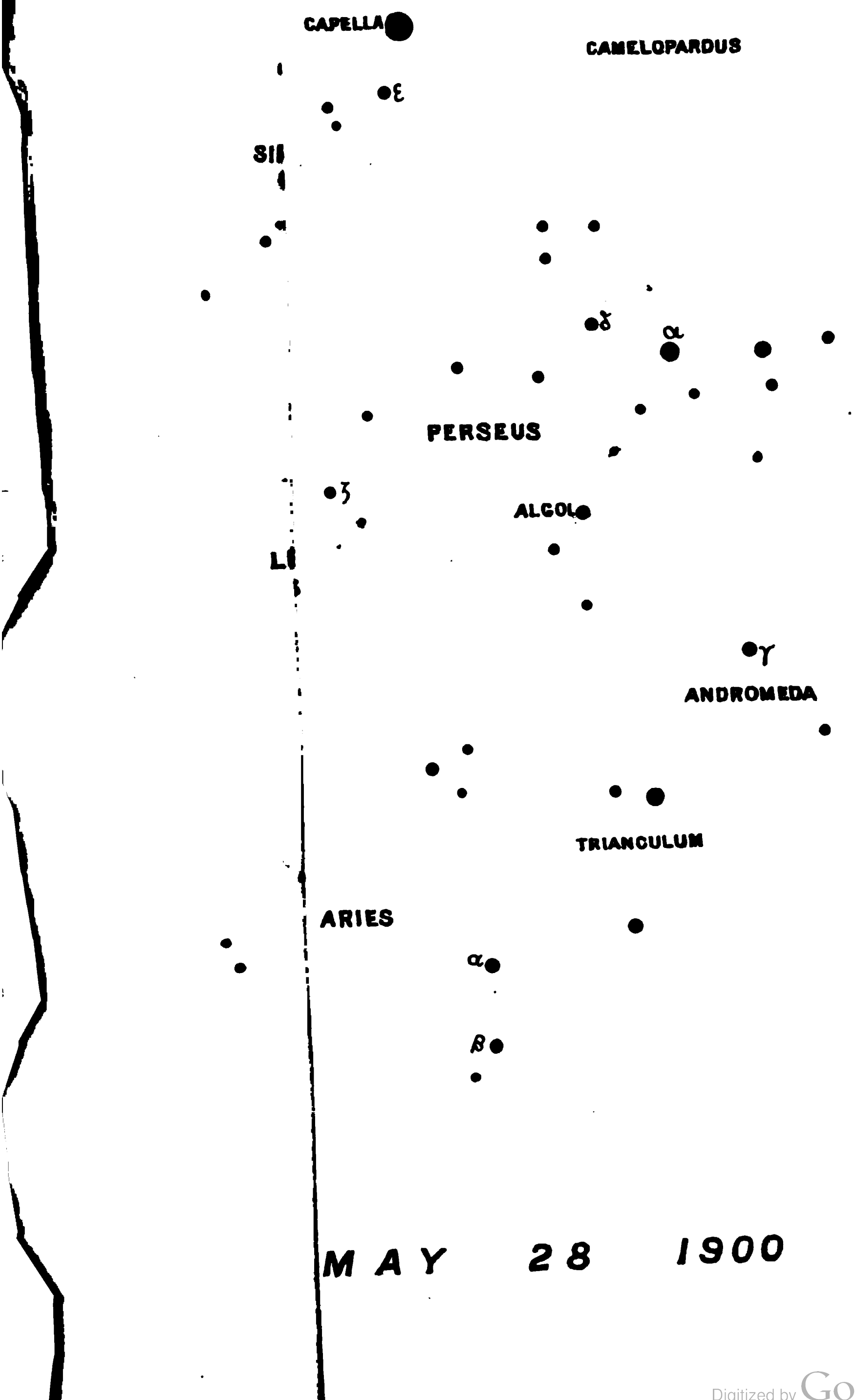
U Ophiuchi.
Every 10th Min.
$P = 20^{h}{\cdot}1$.

	d	h
Feb.	5	4
„	13	13
„	21	23

DM + 12° 3557.

	d	h
Feb.	2	0
„	2	21
„	3	18
„	4	16
„	10	0
„	10	21
„	11	18
„	12	16
„	18	0
„	18	21
„	19	19
„	20	16
„	26	0
„	26	21
„	27	19
„	28	16

Published February 20, 1900


CAPELLA
CAMELOPARDUS
PERSEUS
ALGOL
ANDROMEDA
TRIANGULUM
ARIES
MAY 28 1900

The Journal

of the

British Astronomical Association.

VOL. X. SESSION 1899–1900. No. 5.

British Astronomical Association.

Sion College, 26th March 1900.

The next Meeting of the Association will be held at Sion College, Victoria Embankment, on Wednesday next, the 28th inst. Chair to be taken at 5 o'clock.

The following papers have been received:—

Report of the Meteoric Section. By The DIRECTOR.

The Zodiacal Light Section. By The DIRECTOR.

The Zodiacal Lights and Gegenschein. By FRANCIS J. BAYLDON, R.N.R.

The Ending of the Nineteenth Century. By SAMUEL STUART.

Stanley Williams was an ...

and that they must admit that he really did observe and see tl things which he drew and described. As to M. Antoniadi, no o could study his drawings without seeing how faithful an observ and splendid an astronomical artist he was. It made, therefore, th discrepancy between the two the more interesting and remarkable, and the clearing up of the discordance would undoubtedly be of the utmost value.

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REPORT OF THE MEETING OF THE ASSOCIATION, HELD ON FEBRUARY 28, 1900, AT SION COLLEGE, VICTORIA EMBANKMENT.

W. H. Maw, F.R.A.S., *President*, in the Chair.

J. G. Petrie, F.R.A.S., *Secretary*.

The *Secretary* read the Minutes of the last Ordinary Meeting, which were confirmed.

The names of five candidates for admission were read and passed for suspension, and the election by the Council of eleven new Members was confirmed.

Mr. Maunder read a paper by Mr. A. Stanley Williams on "The Double Canals of Mars" (*see* p. 211).

Mr. Maunder thought they were very fortunate in having this question of the double canals of Mars discussed by two such observers as M. Antoniadi and Mr. Stanley Williams, who were certainly amongst the very keenest observers of planetary detail now alive. He had known Mr. Stanley Williams's observations for a great number of years, and was bound to admit that Mr. Williams seemed to be so successful in detecting what he (Mr. Maunder) thought was minute and impossible detail, that he had regarded his observations with a great deal of scepticism until he actually had the observations in his hands and was comparing them with the work of other observers in the opposition of 1892. He could not resist the conclusion that, wonderful and almost miraculous as some of his observations must seem to be, Mr. Stanley Williams was an extremely careful and acute observer, and that they must admit that he really did observe and see the things which he drew and described. As to M. Antoniadi, no one could study his drawings without seeing how faithful an observer and splendid an astronomical artist he was. It made, therefore, the discrepancy between the two the more interesting and remarkable, and the clearing up of the discordance would undoubtedly be of the utmost value.

Mr. Wesley said Mr. Stanley Williams mentioned that M. Schiaparelli discovered the canals of Mars at the opposition of 1877; but he (the speaker) thought it was a fact that this observer did not see them until some time after the opposition was past, and that he kept seeing them better for some months after that. Mr. Lowell, if he remembered rightly, accounted for this curious fact by seasonal changes, owing to which the canals were not distinct until after the opposition. It appeared that, as the apparent diameter of Mars grew smaller, Schiaparelli saw more canals.

Mr. Nelson said that, with a microscope, the doubling of structure was quite a common phenomenon. It was easier to double structure with a microscope than with a telescope, because, on account of the great difference in their ratios of focus to aperture, there was a greater amount of spherical aberration in a microscope objective. He had, however, tried the experiment with a telescope objective of great excellence, and had succeeded in doubling lines. The telescope in question was a 2-in. by Dallmeyer, of 18-in. focus, the centre being stopped out and only the margin used. When the stop was taken away the lines were, of course, single. His opinion was that spherical aberration in large telescopes was much greater than was generally supposed. He was glad to be able to report that flint and crown glasses, which had their dispersive powers proportional throughout the spectrum, had lately been constructed in Germany, and that, therefore, apochromatism, which had been enjoyed in the microscope for the last 15 years, was now possible in a telescope objective, and he hoped that telescopes far more perfect than any yet known would shortly be made.

Mr. Seabroke remarked that the increase in the diameter of the telescope did not necessarily increase the spherical aberration. The spherical aberration of the lens varied as the square of the diameter over its focal length, and, therefore, with telescopes having the same ratio of focal length to the diameter of the object-glass the spherical aberration was identical. He did not know enough about the canals of Mars to say much on the subject, but he did not think the doubling would depend upon the size of the object-glass.

The *President* said the telescope Mr. Nelson had referred to was 18-in. focal length and 2-in. aperture, proportions which would bear out Mr. Seabroke's remarks. Such a ratio of focal length to aperture—namely, 9 to 1, was, of course, less than in most astronomical telescopes, in which the ratio was generally about 15 to 1 or 18 to 1.

Mr. Saunder pointed out that Mr. Nelson had not told them at what distance he put up his lines. If he might assume that it was not more than 100 yards from the object-glass that would account for his finding spherical aberration. An object-glass could only be corrected for one distance, and for an astronomical telescope, this ought to be for an infinite distance. A glass so corrected must, and ought, to show spherical aberration at small distances.

Mr. Maunder said Mr. Wesley had remarked that Schiaparelli did not discover the canals in 1877 until the opposition was well passed. That was certainly the case; and he believed that at that opposition Schiaparelli observed the canal Titan at a time when the diameter of Mars was very little over 5 secs. of arc, so that, to a certain extent, the contention which Mr. Stanley Williams had urged in his paper was not borne out by the facts of the case. With regard to his own observations of Mars, he (the speaker) had never on any occasion been fortunate enough to see a canal doubled, although in the course of observations of lines, as in the spectrum, he found that when the eye was tired or strained, especially when moving from one part of the spectrum to the other, in which a change of focus was necessary, it was very easy to get all the lines doubled—indeed it was difficult to avoid it. He could not quite think, however, that so skilful and experienced an observer as Mr. Stanley Williams would not be perfectly *au fait* with any spurious duplication of that kind, and it must be borne in mind that his own representations of duplicate canals were comparatively few in number. As Mr. Williams preferred to put it, in certain portions of the surface of Mars they had canals in pairs; sometimes they were only able to see one of them, sometimes the other, and sometimes they saw the two. But, so far as he could recollect, he did not think Mr. Stanley Williams put forward any such complete system of double canals all over the planet, as had been seen on some of the drawings that had been exhibited to this Association on previous occasions.

Mr. Wesley said that in a conversation with Prof. Barnard during his recent visit to England, that gentleman mentioned that, generally speaking, he had not seen the canals of Mars through large telescopes, except once with the Lick telescope, when he saw what he afterwards concluded was a double canal, near the Lacus Solis. There were two very indistinct somewhat parallel lines, not hard and not straight, one of them shorter than the other. They were very different from the canals represented in any of the sketches he had seen.

The *President* hoped Mr. Stanley Williams's paper and the discussion upon it would lead to their receiving another paper from M. Antoniadi. He did not think they had quite got to the bottom of the subject yet; but he felt that a partial explanation, at all events, of the difference of opinion that existed, consisted in the different values attached to certain appearances on Mars by different draughtsmen. A large number of Martian sketches no doubt did show markings very much harder and more distinct than anything that had ever been seen on the planet, and of course people who criticised those drawings critisised the actual drawings, and not what they were supposed to represent. The only way in which they could get to the bottom of the question would be to get two observers, like M. Antoniadi and Mr. Stanley Williams, to meet at the telescope and observe in company, thus being able to discuss the matter on the spot.

Mr. Maunder was sorry to say the Association's Eclipse Expedition was still not definitely decided upon. The Members had doubtless received a circular stating the case as it stood on the date of the issue of that circular, and inviting the Members to join in a guarantee fund. That suggestion was made by one of their intending passengers who, at the same time, offered to guarantee 100*l.* himself. At the present time they had bookings to the extent of nearly 2,200*l.*, and guarantees amounting to about 600*l.*, these two figures together bringing them within about 800*l.* of the total cost of the expedition. The Royal Mail Company, who had very kindly granted them a month's extension, required a definite answer by Monday next, March 5. The matter was so far advanced that he could not think there would be any serious risk in going on; but at the same time they were not in a position to pledge the Association to anything to which they did not definitely see their way. He had not the slightest doubt that if they could hold on until May a great number of people would come forward who could not make up their minds three months beforehand to join the expedition. There was no doubt the war was responsible largely for the present state of things. A large number of names which were given in last autumn had been withdrawn, and there were a good many who hoped to join the expedition, but who could not possibly give in their names definitely because the course of the war might interfere with their arrangements. If, by March 5, they could get, either in guarantees or booking, the remainder of the sum required, they could go forward with the arrangements for the "Tagus." If not, he was afraid that the expedition, by that particular vessel, at any rate, must fall through. Mr. Maunder then showed, with the aid of the lantern, some slides illustrative of the neighbourhood of Elche, near Alicante, which had been presented to the Association by Count de la Baume Pluvinel, who was intending to observe at the former station.

Mr. Maunder, in reply to Col. Burton-Brown, said that about 30 to 35 additional names were required to justify the Eclipse Committee in going forward.

Col. Burton-Brown suggested that if the names were not forthcoming, it might be possible to arrange for a smaller ship to take the Association's expedition, otherwise those who had already announced their intention of going would be seriously disappointed. If all other methods failed, he would be happy to do anything in his power in arranging for those who desired to go to Algiers, but he sincerely hoped that the efforts of the Eclipse Committee would be crowned with success, and then any such assistance on his part would be rendered unnecessary.

Answering Mr. Ellis, *Mr. Maunder* said it was impossible, of course, for the Royal Mail Company to guarantee any particular ship, because any of their ships might be requisitioned for Government purposes. They would, however, let the Association have the "Tagus," if they possibly could, providing, of course, the proposed contract was entered into. If the Association had

to charter a smaller boat, the terms per passenger would, of course, be somewhat higher than those arranged for the "Tagus."

Mr. Maunder further handed round a couple of opera-glasses which had been sent for exhibition by their ingenious fellow Member, Mr. Thorp, of Manchester. One of these was fitted with a prismatic grating before one of the object-glasses; the other, with one at one of the eye-pieces, for the observation of the coronal spectrum during the coming eclipse.

Mr. Petrie read a paper, by the Rev. D. R. Fotheringham, on "The Rise and Fall of Astrology" (*see* p. 209).

Mr. J. D. Hardy thought that in this question a great deal depended upon the period to which they referred. In an article in "Knowledge," Mr. Maunder had given them the date of 1200 B.C. It was very easy to go back, by studying the signets in the Assyrian room in the British Museum, to 4,500 B.C., and it could be seen that the astrologer at that time observed the rising and culmination of the stars so as to form what they considered to be a forecast, or horoscope, of the child that was about to be born. The astrologer was there on the spot with his observations as to what the future life of the infant was likely to be. If it were a fortunate one, they took care to have it engraved on the signet, which was carried about by the child ever afterward. This was of some astronomical interest, as the root of the word used by the Assyrians for the signs (Zodiacal) and the signet was the same—as they are with us. It was thus possible to go far enough back to show that the observation of the stars was made purely by astrologers; but they could go further back than that, for they might consider the Arabs as being really the originators of astronomy. They had cause for it, because they had only the desert to roam about in, and it was absolutely necessary for them to observe the stars for the purpose of knowing where they were; but they did not make any observation of the stars for the purpose of astrology. That was before they settled in Chaldæa and became both astronomers and astrologers. Then came the question, when one branch of these nomadic shepherds crossed over into Egypt, whether they took with them the knowledge of astronomy so far as they then understood it. We had no knowledge at all of the time when astronomy began in Egypt—there was nothing like the Assyrian signets to give us evidence as to that; but considering that these signets could be traced back to 4,500 B.C., there was every reason to suppose that the study of astronomy by the Egyptians would go back even further than that.

Mr. Crommelin remarked that it seemed rather an abuse of the established meaning of terms to talk about things like the tides or the sympathy of the terrestrial magnetic cycle with sunspots as astrology. The term "astrology" was generally used in the sense of the supposed effect of the heavenly bodies upon purely human affairs. The writer of the paper appeared to steer clear of any definition of the word. It was quite true that it would be of interest, and might be of some use, to study the systems of the old astrologers from an historical point of view; but he

did not agree with the writer of the paper that such work was at all connected with the science of astronomy.

Mr. Maunder thought it was clear that we owed one debt to the astrologers, viz., that in some sort they kept up the science of observational astronomy for some 2,000 years. Of course, astronomy from a theoretical point of view made absolutely no progress in the astrological period, because the stars and planets were observed simply for the purpose of making forecasts and predictions, and not in order to further physical research. But during that interval of 2,000 years the astrologers had kept up the science of observation to a certain degree, and such tables of the motions of the planets as were formed during that period were due to astrology. That seemed to him to be the chief interest of astrology to us at the present time, and the chief debt we owed to the astrologers.

Mr. J. D. Hardy read a paper on "The Enlargement of Heavenly Bodies," and *Mr. Maunder* read a note by the Rev. Joseph Allen, maintaining that the apparent enlargement of the sun and moon when near the horizon, was purely illusory (*see* p. 211).

Mr. McCarthy thought there seemed very slight approach to a more reasonable explanation of the strange difficulties in connexion with the subject of apparent enlargement. It was now broken up into two sections. One was confined to the question of the moon and sun, and the other to the apparent enlargement of the constellations. He could hardly see how the explanation put forward by the first paper could make it clear how it was that the component stars of any and every constellation when seen on the horizon seemed further apart, and the constellation covered a much larger area than when on the zenith. He was afraid he could not offer any intelligent explanation himself; he simply pointed out the difficulty, which was, that when measured by the instrumental means they possessed, there was no apparent difference at all in the size of the sun or moon when seen on the horizon as compared with their size when seen at the zenith. On photographs the sun and moon always appeared the same size, though so different to the unaided eye. Neither instruments nor photographs appeared as yet to have been applied to the constellations for this purpose. Another consideration which helped to complicate the question was the fact that the moon was by no means constant. Viewing the moon after an interval of two or three days, allowing for change as to fulness or otherwise, there were times when it did not look anything like so large as it did at other times. This arose, he thought, from the differing conditions of the atmosphere, and, if so, all supposition about the difference arising from the construction of the eye and the position of the observer vanished at once. They thus found themselves at last, instead of being in a definite position, once more to have come to a state which they might almost call "confusion worse confounded."

Mr. Seabroke considered the phenomenon purely physiological. The size on the retina of the image of the moon, or the distance between any two stars when seen on the horizon, and when seen

in any other position, must be exactly the same if they eliminated atmospheric refraction; but it was a matter of custom, physiologically, he thought, to imagine objects to be larger when seen near the horizon than when seen in any other position, just as it was the custom to combine into one the two images seen by each eye. He had often noticed that the size of a clock dial when seen a little above the horizontal line, appeared much smaller than it would do when down lower. It was customary to imagine things smaller when seen up high than when seen on the ground. He thought Mr. Hardy had rather mixed two things—refraction and reflexion. If they looked at the moon through a certain amount of atmosphere, that atmosphere had the effect by refraction of reducing the size of the moon rather than increasing it—it lifted up the lower portion in a greater degree than the upper portion—and consequently the moon looked compressed when near the horizon, its vertical diameter in such a case being less than its horizontal. That was a clear argument against refraction increasing the apparent diameter, and so accounting for the effect under discussion.

Mr. Maunder said the discussion reminded him of an incident in the memoirs of that great explorer and most acute observer, Capt. Lemuel Gulliver. (Laughter.) On returning to England from his voyage to Brobdignag, he thought he had got back to Lilliput, and was like to have gotten his head broken several times because he called to the people to get out of his way lest he should tread on them. It was easy to understand Capt. Gulliver's impression. Looking at people standing a good way off, it was perfectly easy to imagine that they were only six or seven inches high, if we chose to conjure up that illusion. Knowing, however, that they were actually five or six feet high, we regarded them as such. We were helped to the proper estimation of the true size of a person or object by being able to see intervening objects, and to form from them a pretty good guess as to the distance off of the person at whom they were looking. When looking into the sky they had nothing whatever to guide as to the distance above them of the objects of their attention. They were thus looking at objects under two different conditions. Nothing was more difficult to estimate than distance, and next to that the angular dimensions of an object were most hard to judge rightly. There was no doubt also that they got the idea that the moon or sun was larger when seen through a dense atmosphere, and when it looked red and dull, and he believed that also was a feature of the same order—it was an illusion pure and simple. He remembered on one occasion seeing a sunset over London, the sun being exactly behind the dome of St. Paul's. He could not see the dome at all, until all of a sudden he began to think that an unpredicted eclipse was coming on, as a big moon seemed to be making its way on to the sun. Finally, the sun actually touched the horizon with the dome in the image of the sun—it just went in, cross and all. He was sure, however, that if anyone were to compare the sun overhead with the dome of St. Paul's from Blackheath, they would say that the dome was three or four times the diameter of the sun, and yet on the occasion referred to it went comfortably into the disk of the sun. Similarly, as an

illustration of the difficulty of carrying an apparent distance in one's eye, most people would say that the moon would obliterate the whole of the Pleiades at once, which it certainly could never do. It would require two or three moons side by side to obliterate the Pleiades, and yet the impression produced upon one's mind was that the moon was bigger than the group. The first time he saw a total solar eclipse he was greatly astonished to see how very small it was. The black moon, seen on the light background—the corona—seemed very much smaller than the bright moon as seen in the sky.

Mr. Crommelin thought Mr. Hardy's suggestion would explain the prismatic rings and colours which were often seen round the moon; that was a sort of effect that would be produced by the scattered light of which he had spoken It would not tend to increase the true disk of the moon, but would make some scattered light outside, which there would be no risk of confusing with the true disk. He could say with confidence that the true disk was not of greater magnitude on the horizon than when higher up, for he had observed it with an altazimuth when only 3° high, and the size was within a few seconds of arc of the tabulated size—a quantity not to be noticed by the naked eye. Refraction diminished the size vertically, but not horizontally; when just rising it did so to the extent of six minutes of arc, or one-fifth of the whole diameter—a very sensible quantity. He agreed that the effect of apparent enlargement was only physiological, that it existed only in our instincts and consciousness, and was not at all an external measurable quantity.

Mr. Newbegin remarked that the photographic plate appeared to photograph heavenly bodies the same size at whatever angle, but we never seemed to see them so. Did this not rather lead us to ask what it was in ourselves that led to this illusion? Had we gone far enough with our query as to the reason why?

Col. Burton-Brown said it had often been observed that people were very imaginative over some of these astronomical phenomena. He, therefore, wished to give an illustration to the contrary. When cruising on the coast of Norway some time ago, he, with a number of others, were observing the sun set on the sea horizon, the atmosphere being extremely clear. As the sun passed about half-way below the horizon, it seemed to quickly draw out; the upper portion became flatter and flatter, and instead, ultimately, of seeing a small arc of the sun, its whole length was seen, indeed, it appeared to be about one-third as much again as the original axis of the sun. The others observing the phenomena described, quite independently, exactly what he had seen, so that there was no imagination about it whatever. He therefore thought atmospheric and other circumstances, with regard to the constellations and the sun and moon as seen on or near the horizon, and at the zenith, might be materially opposed to each other. Under these circumstances he did not see why it might not be possible to pull out the stars of constellations, and make them *look* very different near the horizon from what they looked at the zenith.

The *President* said one point about the apparent enlargement of the constellations near the horizon was that the effect was seen when they were much higher above the horizon than in the case of the sun or moon. In the case of the sun or moon the enlargement was not noticeable unless the object was within a degree or so of the horizon; but in the case of the constellations it was noticed when the stars were 6° or 7° above the horizon. Castor and Pollux always seemed to him a most remarkable instance of such enlargement. The separation of those two stars when they were near the horizon seemed enormously greater than when they were in a higher position.

Mr. Mark Wicks expressed the opinion that it was not always the density of the atmosphere which caused the apparent increase, and gave instances which led him to entertain this view.

Mr. Holmes said that to him the enlargement had no existence on clear evenings, for he was then unable to see any difference in size whether the sun or moon was on the horizon or high up. The fact that the sun and moon often looked considerably larger when the evenings were misty and the air thick seemed to him perfectly explicable from the fact that they got a considerable border of atmosphere round the edge of the sun or moon illuminated so strongly that it appeared to be a portion of the sun or moon itself. On those occasions they did not see either the sun or the moon very distinctly. The features were obliterated, and the edge became diffused, and they naturally had the idea that it looked considerably larger than when higher up. But he took it there were no photographs taken on those occasions.

Mr. Wesley.—But that would not apply to constellations. I have seen them on most brilliant nights appear wonderfully large.

The *President* said that Mr. Holmes's remarks did not apply to the apparent enlargement of the sun seen through a fog. Some of the most striking enlargements of the sun were seen when there was a yellow, apparently distant, fog—not a fog in the region around the observers. In that case they got a particularly sharp edge to the solar disc. There was certainly far less diffusion of light than when they looked at the sun in the ordinary way.

Mr. Holmes.—On those occasions I see no apparent enlargement.

Mr. Hardy said that on the question of photography neither the camera nor the telescope would show any difference at all. It was not easy to measure the moon either by the one or the other when on the horizon. As to the constellations there was a mixing up of the questions of refraction and reflexion as understood according to the laws of light.

Some enlarged photographs of portions of the moon taken at the Lick and Paris Observatories, and of which lantern slides had been prepared by the Royal Astronomical Society, were thrown upon the sheet, and explained by Mr. Goodacre.

The meeting adjourned at 7 p.m.

Reports of the Branches.

NORTH-WESTERN BRANCH (MANCHESTER).

The Fifth Meeting of the Session was held on February 7th the President Prof. T. H. Core, M.A., in the Chair.

The preliminary business, including the inauguration of the lantern, which this Branch has acquired for use at its Meetings, having been disposed of, drawings of the planet Jupiter, 46 in number, recently executed by Members of the Section, and kindly lent by the Director, Mr. Arthur Cottam, F.R.A.S., were examined and discussed, after which the President gave a lecture on—

> "The kinetic theory of gases in relation to the atmospheres of planets and satellites."

The first part of the lecture consisted of a historical survey of the atomic and molecular conception of matter from the crude ideas of the Greek philosophers to the formal laws enunciated by modern investigators.

The nature of the formulæ and equations relating to mass acceleration, space velocity, and energy which underlie the *quantitative* consideration of all mechanical questions having been made clear, the nature of the kinetic theory of gases was explained and illustrated by experiments on the diffusion of gases, and with the radiometer. It was shown how the laws of Boyle, Charles, Avogadro, Graham, and Dalton, were, according to the kinetic theory, capable of simple numerical investigation and confirmation by the aid of the fundamental mechanical equations discussed in the earlier part of the lecture.

The velocity and the paths of the molecules of certain gases at varying temperatures and different degrees of tenuity having been considered, the lecturer explained the views set forth by Dr. George Johnstone Stoney in regard to the atmospheres of planets and satellites, showing how the permanent constituents of an atmosphere are affected by the attractive force of gravity on each planet. For instance, as regards the earth, although hydrogen and helium are being constantly added to our atmosphere, the most careful analysis fails to indicate their presence. This is what would be expected according to the kinetic theory which shows the velocity of the molecules of these gases in our atmosphere to be such that the attraction of the earth is not sufficient to retain them, and consequently they leak away into space.

In a similar manner many of our gases, for instance water vapour, would quit the moon, Mercury, and Mars, so that the white polar patches on Mars are probably due to CO_2. Jupiter and Saturn are able to retain all the gases known to chemists, while the atmospheres of Venus, Uranus, and Neptune, would appear to much resemble that of the earth.

The lecturer expressed his full concurrence with the views of Dr. Johnstone Stoney.

WEST OF SCOTLAND BRANCH (GLASGOW).

The Fifth Meeting of the Sixth Session was held in the Rooms of the Philosophical Society, 207, Bath Street, on Friday evening, 16th February, at 8 o'clock. The Rev. Edward Bruce Kirk, President, occupied the chair, and there was a large turn out of Members and friends. The Chairman, in introducing Prof. Knott, briefly referred to the kindness of the lecturer in coming from Edinburgh to address them. Prof. Knott, D.Sc., F.R.S.E., then delivered a lecture on "The Luminiferous Aether," considered under three headings; first, the necessity for the aether in order to account for the phenomena of light; second, the functions of the aether; and third, the constitution of the aether.

At the outset he referred to the corpuscular theory of light in the form elaborated by Newton, who was nevertheless compelled to assume the existence of an aether as well. On the other hand, by assumption of a suitable kind of aether, we can dispense altogether with the corpuscles. Certain properties of the aether were then demonstrated experimentally by means of the spectrum of the electric arc. By use of a fluorescent screen the great extension of the spectrum beyond the violet was demonstrated, and the still greater extension of the spectrum beyond the red was described. There was no reason for assuming that the rays now known to exist include all that are really present. The production of a spectrum by means of a diffraction grating was then demonstrated, and the method explained by which the wave-lengths of light may be measured. A certain relation was shown to exist between colour and wave-length in light, just as in sound pitch and wave-length were closely related. The simplicity of the explanation given by the wave theory of light of such phenomena as the colours of soap films, and the experiment (which was shown) known as Newton's Rings, was dwelt upon, the succession of colours in the latter experiment being shown to be due to interference in two trains of waves originating simultaneously at the same source, but afterwards separated so that the one train lagged behind the other by one, two or more wave-lengths of the ray of predominant colour. The lecturer then showed a large diagram of the complete solar spectrum from wave-length 2/100,000 to 54/100,000 centimetre, touching briefly on the significance of the various absorption lines and bands. Small portions of the spectrum were then thrown on the screen, as also spectra of stars and other heavenly bodies. A series of slides was shown of a region 3° square in the constellation Argus, being the reproduction of Dr. Gill's photographs taken with exposures of 5 minutes, 45 minutes, 3 hours 12 minutes, and 12 hours 12 minutes. These revealed the vast superiority of the camera in light-grasping power over the human eye. The eye responds to immediate impressions and gets fatigued, whereas the photographic plate after prolonged exposure receives a record of lights far too faint to be observed even with the aid of the most powerful telescope ever imagined. As to the constitution of this aether, which brings us into direct contact with the furthest

bounds of the universe, we knew as yet very little. It seemed to behave like a very rare fluid to mass motions through it, yet it was gripped most effectively by the vibrating molecules of matter, and, in its power of transmitting waves, closely resembled a highly elastic solid. It was now recognised that the aether was the vehicle, not only of light and radiant heat, but also the medium through which electric and magnetic action took place. The mind of man would never be satisfied till it had imagined an aether capable of explaining light, radiant heat, electricity, magnetism, and that greatest of all physical mysteries, gravitation itself.

The Chairman, in a few remarks, spoke of the able and deeply interesting lecture to which they had been treated, and moved a very cordial vote of thanks to the lecturer. Prof. Knott, in briefly replying, said that if his lecture that evening should prove the means of starting any of his audience in the study of this subject, he would feel amply repaid. A vote of thanks to the Chairman closed the meeting.

EAST OF SCOTLAND BRANCH (EDINBURGH).

The fifth Meeting of this Branch was held at No. 5, St. Andrew Square, Edinburgh, on the evening of Saturday, 17th February, the President in the chair. A lecture on "Recent Observations of Venus," was given by Mr. Henry MacEwen, F.R.A.S., Director of the Mercury and Venus Section, who explained that he had found his drawings unsuitable for lantern slides, and consequently the promised limelight views could not be shown.

Mr. MacEwen, in the first place, gave a resumé of observations of the planet, describing more particularly those of Schiaparelli, Perrotin, and Brenner. He dealt at some length on the long and short rotation periods, and then went on to give particulars of his own observations of the planet since 1892 with a 5-inch Wray refractor. Mr. MacEwen described in detail the appearance of the disk at each successive elongation, and illustrated his remarks with the aid of the black-board, and a large number of beautiful drawings of the planet at all phases. He pointed out that the planet, when the disk was small, was, as a rule, most interesting, while little or nothing could be seen when it was a crescent. He had on some occasions actually seen motion in the markings, had arranged an ephemeris of transits of the central meridian of certain markings, and had been able to deduce a provisional rotation period for the planet. He explained, however, that he had not yet completed his investigation into this question, but was still waiting for further observations.

The lecture was listened to with much interest by the Members, and Mr. MacEwen received a hearty vote of thanks. He was desired to convey to the Members of the West of Scotland Branch the hearty good wishes of the Eastern Section. Some discussion followed, various points in the lecture being brought up, and some questions by both speaker and hearers were answered.

The Sixth Meeting of this Branch for the current Session took the form of a visit to the City Observatory, Calton Hill, Edinburgh, on the evening of Wednesday, 7th March. The Members were welcomed by Mr. Peck, the City Astronomer, in a short speech, and the party was thereafter conducted round the buildings by Mr. Ritchie, the chief assistant, who gave much interesting and useful information in regard to the various instruments examined. In this way the Crawford reflector of 13-in. aperture, the altazimuth instrument, the standard clocks, the transit instrument, and the mural circle, were visited, while the 6-in. Cooke refractor was in use upon Venus, the moon, and other celestial objects when the clouds permitted. The weather improving somewhat, a good view of the moon was obtained through the large refractor of 22 inches aperture, a magnifying power of about 600 being used. Other celestial objects were also shown through the reflectors, including the star cluster in Perseus, and the double stars γ Leonis.

There was a large attendance of Members, and the visit was thoroughly enjoyed.

Papers communicated to the Association.

The Rise and Fall of Astrology.

(Being the substance of an Essay read before the East of Scotland Branch by the Rev. D. R. Fotheringham, M.A.)

We are so much accustomed to regard astronomy with the utmost respect, if not actual reverence, and astrology with feelings so exactly the opposite of respectful or reverential, that the astronomer is little inclined to recognise any kinship between the two sciences. Yet for more than five thousand years it was not a case of kinship between them, but of actual identity. Tycho Brahé had his attention first drawn to astronomy by observing the fulfilment of a predicted eclipse of the sun. Giving his mind to the study of such conjunctions and other aspects as could throw the earth into darkness or produce equally striking disturbances, he soon discovered one that would cause the death of the Sultan of Turkey in the following year. The prediction was more than fulfilled, for the Sultan was already dead, though Tycho did not know it. But it is important to notice that as late as 1560 absolutely no distinction was drawn between astronomy and astrology. The predictions of eclipses or of deaths were regarded as equally proper to the science. Even now it would be difficult to draw a hard and fast line between the two. Such questions as relate not only to eclipses but to the tides, the calendar, the weather, navigation, and the like, are as much astrological as astronomical. If the moon is seen with a halo round it, and wet weather follows; or if spots on the sun are connected with magnetic disturbances and the aurora borealis, we are dealing with astrology pure and simple.

It is easy to see how the stars become our guides and monitors. A village sportsman who takes his gun out every fine evening in September takes it home again as soon as he sees Capella in the

N.E. The question of how many degrees the sun has sunk before a star of photometric magnitude 0·2 can be seen at a given altitude does not appeal to him. But he knows perfectly well as soon as the star can be seen his chance of sport is gone, and, in short, Capella orders him home. In the same way the hunter, the ploughman, the herdsman, and the sailor of old time had their actions disturbed by the stars, and the heavens provided them with an infallible calendar, chart and compass. Now logicians teach us to distinguish the *causæ essendi* from the *causæ sciendi*, but the practical importance of the distinction is nil. We prepare for a storm when the barometer suddenly drops, just as surely as we would if we could trace the gathering together of the winds. The mariner steers for the pole star, though with no expectation of reaching it, because he knows that by so doing he will keep a straight course to the north. The farmer sows his seed when he sees the Pleiades, not because they remind him of a handful of corn, but because he knows it is time. At a very early time the sun, moon, and fixed stars became the monitors and directors of our lives, and astronomy and astrology were thus born together.

But how about the planets, the intricacy of whose motions soon gave them an all-absorbing interest? Clearly their influence is of a more subtle character, and not to be determined by the same rough methods of observation that revealed the character of the sun and moon's influence, or even that of the stars, and, since their motions are so complex, it is natural to suspect that their influence will be complex too. If the stars have been proved to be man's truest counsellors, surely the planets—could their voices only be translated—would be the truest of all. Given, then, this problem of intense absorbing universal interest, make the least possible allowance for hasty inductions, or deceptive analogies, and we have the whole explanation of the rise of the greatest delusion that ever enslaved the mind of man.

But before condemning astrology altogether, one caution is needed. Dotted here and there all over our islands are numerous mineral wells and springs. The medical properties of these were well-known to the ancient inhabitants of the island, who assigned them to the influence of local gods and spirits. In the Middle Ages the same virtues were attributed to the Virgin Mary and other saints or angels. But as the result of a religious upheaval which affected Western Europe about the time that astrology fell into discredit, these "healing wells" were discredited also, and recourse to them was denounced as superstitious. We are now beginning to discover that in a good many ways our remoter forefathers were in the right, and that the medical properties of these wells were real and beneficial. Now it is at least conceivable that something of the sort may be the case with astrology, and without accepting all the absurdities that have become interlaced with the science, there may be (nay, there undoubtedly is) a certain *residuum* worthy of all respect.

In any case the pretexts of modern astrologers must go. The division of the signs of the Zodiac among the planets (two for each planet, Cancer for the sun, and Leo for the moon) has been stultified by the discovery of Uranus and Neptune. Astrologers might have adopted the bold course of denying the influence of those planets altogether; instead of this they have patched up a

compromise between the old science and its modern devolopment, the result of which is that they themselves prove that astrology was utterly untrustworthy during the many centuries when it was believed, and that we can never again be sure of its trustworthiness. On the question of the *Aspects* too, modern astrologers are hopelessly astray, and show none of the discernment or ability that marked the work of their predecessors. In regard to the *Houses of Heaven*, it is simply a question of spherical trigonometry to show that the elaborate tables in Zadkiel and Raphael are altogether wrong. As to the spiritualists who have added their dreams to what ought to be a purely mathematical science, they hardly seem to come within the scope of this essay. The conclusion seems to be that astrology might be all very well if it were not for the astrologers.

It is desirable that some of us at least should study astrology, for without a knowledge of it some of our oldest literature becomes unintelligible. As an amusement or mathematical recreation it might be as good as chess. Finally, I may confess, that I have sometimes invoked the aid of astrology myself, and see no reason for being dissatisfied with the result.

The Double Canals of Mars.

By A. Stanley Williams, F.R.A.S.

My paper on the subject of the double canals of Mars seems to have given rise to such an interesting discussion at the December Meeting of the Association, as to make me regret very much that I was unable to be present. Some of the objections raised have already been answered by others, but there are several points on which I should like to make a few remarks.

First, with respect to M. Antoniadi's notes on my paper, I thought that I had already given sufficient reasons why a particular canal might be described as double by one observer and only single by another at the same time. Differences of eyes, telescopes, magnifying powers, weather and skill and training of observers appear to me amply sufficient in themselves to explain disagreements of this kind, without its being necessary to seek for other cause, though some additional reasons were referred to in my paper. In this connexion it is possible to adduce a case of disagreement of an analogous but even greater magnitude, and an instance moreover which is fortunately based upon irrefragable evidence. Eight or nine years ago one of the belts of Jupiter (the north temperate belt) was very conspicuously and definitely double. The duplicity was in fact so coarse, that the belt was actually photographed double at the Lick Observatory. There are a large number of contemporaneous drawings and observations of Jupiter, some of them by most skilful and experienced planetary observers, but there are only a few instances of the belt having been seen double. Most of the observers seem only to have seen it single. Yet in this case the duplicity was almost incomparably coarser and easier than the duplicity of the double canals of Mars.

It should be remarked with regard to M. Antoniadi's first note, that my present arguments are based upon the plainer

canals, which, to the writer at any rate, *are* continually visible on a good night. Hence there can be no question as to the possibility of experimenting directly upon such objects, and unless these streaks were possessed of sufficient definiteness and *strength* to stand being doubled by putting the image deliberately out of focus, which they do not, I do not see how they could stand being doubled in any other way.

With reference to Father Cortie's objection to the analogy between observing the canals of Mars and double stars, I should rather have thought that the fact of the stars being bright points on a dark sky really increased the difficulty experienced in seeing the duplicity of the latter, every imperfection of eye, telescope, or weather being brought out by the intense contrast. The comparison drawn between photographs of stars and those of planets also hardly seems to me a happy one, as on reflection it will be evident, I think, that the photographic star images are in reality at least as defective as the planetary ones. The photographic resolving or separating power of telescopes on double stars is in fact at present several times inferior to the visual separating power. Moreover the image of a bright star on a photograph may be 40″ or more in diameter, and it can hardly be said that such an image gives even an approximately correct representation of the star, so that the definiteness of this image on the photograph is clearly not due to the sharpness or distinctness of the stellar image in the telescope.

But the analogy between the double canals and double stars is actually much more favourable to my views, since the canals are streaks, and not dots or points. Let anyone examine some such double star as 36 Andromedæ on a pretty good night with a telescope not less than 6-in. in aperture. If larger, so much the better. Then in place of two little round dots, suppose each dot drawn out into a line 5″, say, in length, and it will be evident, I think, that the ease with which the duplicity could be distinguished would be much increased, and the baneful effects of atmospheric disturbances much diminished. I do not fancy, moreover, that much difficulty will be experienced in seeing the star double, notwithstanding what has been said about the difficulty in determining whether a star is single or double.

The duplication of a micrometer wire, it should be mentioned, is quite familiar to me, and I have sometimes had such a wire bisecting the disk at the time when a double canal was under observation; so that if the duplicity of the latter had been due to the image being out of focus by any change in the accommodation of the eye, or by diplopia, the much more evident duplication of the wire at the same time could scarcely have escaped notice.

The statements by Capt Noble and Mr. Holmes to the effect that the most wonderful things on Mars have been seen when the planet was a long way off from the earth and badly situated, will not, I venture to think, bear investigation. For instance, the canals themselves were first seen in quantity (a few of the plainer ones, as is well known, date back to the time of Herschel and Schroeter), by Prof. Schiaparelli, during the celebrated opposition of 1877 to which Capt. Noble specially referred. The first double canal was seen, again by Prof. Schiaparelli, at the succeeding opposition of 1879, an opposition little less favourable

than the famous one of 1877. Probably the most wonderful collection of things observed on Mars is that due to the observers at Mr. Lowell's observatory. But here, again, these wonderful things were seen during the opposition of 1894, which was likewise little less favourable than that of 1877.*

List of Comets observed since the beginning of 1889.

By A. C. D. Crommelin, F.R.A.S.

The following list has been prepared in accordance with the suggestion of a correspondent:—

Provisional Designation.	Permanent Number.	First seen.	Perihelion Passage.	Discoverer.	Name.	Period. Years.
1888 *e*	1889 I.	Sept. 2	Jan. 31	Barnard, Brooks -	—	—
1889 *a*	—	Jan. 14	—	Brooks . .	—	—
1889 *b*	1889 II.	Mar. 31	June 10	Barnard . .	—	—
1889 *c*	1889 III.	June 23	June 20	„ . .	—	128
1889 *d*	1889 V.	July 6	Sept. 30	Brooks . .	Brooks . .	7·07
1889 *e*	1889 IV.	July 19	July 19	Davidson . .	—	5,000
—	—	Aug. 1	Oct. 8	Barnard . .	Companion to *d*.	—
1889 *f*	1889 VI.	Nov. 16	Nov. 29	Swift . .	Swift . .	8·92
1889 *g*	1890 I.	Dec. 12	Jan. 26	Borelly . .	—	—
1890 *a*	1890 II.	Mar. 19	June 1	Brooks . .	—	—
1890 *b*	1890 III.	July 18	July 8	Coggia . .	—	—
1890 *c*	1890 VI.	July 23	Sept. 24	Denning . .	—	—
1890 *d*	1890 V.	Oct. 6	Sept. 17	Barnard . .	d'Arrest .	6·69
1890 *e*	1890 IV.	Nov. 15	Aug. 6	Zona . .	—	11,000
1890 *f*	1890 VII.	Nov. 16	Oct. 26	Spitaler . .	Spitaler .	6·38
1891 *a*	1891 I.	Mar. 29	Apr. 27	Barnard, Denning	—	—
1891 *b*	1891 II.	May 1	Sept. 23	Spitaler . .	Wolf . .	6·82
1891 *c*	1891 III.	Aug. 1	Oct. 17	Barnard . .	Encke . .	3·30
1891 *d*	1891 V.	Sept. 27	Nov. 14	„ . .	Tempel-Swift .	5·48
1891 *e*	1891 IV.	Oct. 2	Nov. 13	„ . .	—	—
1892 *a*	1892 I.	Mar. 6	Apr. 6	Swift . .	—	—
1892 *b*	1892 II.	Mar. 18	May 11	Denning . .	—	—
1892 *c*	1892 IV.	Mar. 18	June 30	Spitaler . .	Winnecke .	5·82
1892 *d*	1892 VI.	Aug. 28	Dec. 28	Brooks . .	—	—
1892 *e*	1892 V.	Oct. 12	Dec. 11	Barnard . .	Barnard, 2 .	6·52

* Probably a good many observers would consider the oppositions of 1879 and 1894 to have been really more favourable than that of 1877, on account of the planet's attitude having been greater to observers in the northern hemisphere.

Provisional Designation.	Permanent Number.	First seen.	Perihelion Passage.	Discoverer.	Name.	Period. Years.
1892 *f*	1892 III.	Nov. 6	June 13	Holmes	Holmes	6·90
1892 *g*	1893 I.	Nov. 19	Jan. 6	Brooks	—	—
1893 *a*	1893 III.	May 17	July 12	Finlay	Finlay	6·62
1893 *b*	1893 II.	July 8	July 7	Rordame, Quénisset.	—	44,000
1893 *c*	1893 IV.	Oct. 16	Sept. 19	Brooks	—	—
1894 *a*	1894 I.	Mar. 26	Feb. 9	Denning	Denning, 2	7·698
1894 *b*	1894 II.	Apr. 1	Apr. 13	Gale	—	1,001
1894 *c*	1894 III.	May 8	Apr. 23	Finlay	Tempel, 2	5·21
1894 *d*	1895 I.	Oct. 31	Feb. 4	Perrotin, Wolf, Cerulli.	Encke	3·30
1894 *e*	1894 IV.	Nov. 20	Oct. 12	E. Swift	de Vico (?)	5·86
1895 *a*	1895 II.	Aug. 20	Aug. 20	Swift	Lexell (?)	7·19
1895 *b*	1896 II.	Sept. 26	Mar. 19	Javelle	Faye	7·51
1895 *c*	1895 IV.	Nov. 17	Dec. 18	Perrine	—	—
1895 *d*	1895 III.	Nov. 21	Oct. 21	Brooks	—	—
1896 *a*	1896 I.	Feb. 14	Jan. 31	Perrine, Lamp	—	—
1896 *b*	1896 III.	Apr. 15	Apr. 17	Swift	—	—
1896 *c*	1896 VI.	June 20	Nov. 3	Javelle	Brooks, 2	7·07
1896 *d*	1896 IV.	Aug. 31	July 10	Sperra	—	—
1896 *e*	1896 V.	Sept. 4	Oct. 25	Giacobini	Giacobini	9·0
—	—	Sept. 20	—	Swift	—	—
1896 *f*	1897 I.	Nov. 2	Feb. 8	Perrine	—	—
1896 *g*	1896 VII.	Dec. 8	Nov. 24	„	Perrine	6·4
1897 *a*	1897 II.	June 28	May 21	„	d'Arrest	6·69
1897 *b*	1897 III.	Oct. 16	Dec. 8	„	—	—
1898 *a*	1898 II.	Jan. 2	Mar. 20	„	Winnecke	5·82
1898 *b*	1898 I.	Mar. 20	Mar. 17	„	—	322
1898 *c*	1898 III.	June 7	May 26	Grigg	Encke	3·30
1898 *d*	1898 VII.	June 11	Sept. 14	Coddington-Pauly	—	—
1898 *e*	1898 VI.	June 14	Aug. 16	Perrine	—	—
1898 *f*	1898 IV.	June 16	July 4	Hussey	Wolf	6·82
1898 *g*	1898 V.	June 18	July 25	Giacobini	—	—
1898 *h*	1898 IX.	Sept. 12	Oct. 20	Perrine, Chofardet	—	—
1898 *i*	1898 X.	Oct. 20	Nov. 23	Brooks	—	—
1898 *k*	1898 VIII.	Nov. 14	Sept. 20	Chase	—	—
1899 *a*	1899 I.	Mar. 3	Apr. 13	Swift	—	—
1899 *b*	1899 III.	Mar. 5	May 14	Wolf	Tuttle	—
1899 *c*	1899 IV.	May 6	July 28	Perrine	Tempel, 2	5·21
1899 *d*	1899 II.	June 10	Apr. 28	„	Holmes	6·90
1899 *e*	1899 V.	Sept. 29	Sept. 13	Giacobini	—	—

There was also a comet photographed during the Total Solar Eclipse of 1893, April 16, which was not seen again, and is not included in the list.

The designation by letters follows the order of discovery, that by Roman numerals the order of Perihelion Passage.

The year in Column 3 is the same as in Column 1. The year in Column 4 is the same as in Column 2.

Only periodic comets have a name inserted in the 6th column.

Many of the periods given in the last column are only rough.

Correspondence.

The Cœlostat.

In view of what is apparently the great utility of the Cœlostat, I venture to hope that some Member may be prevailed upon to give a description of the instrument, illustrated if possible, together with an explanation, somewhat after the manner of Loomis, of the method of adjusting it, and the telescope employed in conjunction with it. Many Members, I feel certain, besides myself, would highly appreciate this, whether given in the form of a paper read at one of our meetings or of a letter in the "Journal."

Prof. Turner in "Monthly Notices," Royal Astronomical Society, Vol. LVI., No. 8, p. 408, May 1896, gives what is evidently a most able and thorough exposition from a mathematical point of view of the principles of the instrument; referring also in the course of his "Notes" to a paper by Dr. Schuster in the "Phil. Trans.," Vol. CLXXX., 1889, pp. 291–350. But the Professor's mathematics certainly, and probably also those of Dr. Schuster, go further than I, for one, can follow them, except in the blind use of the formulæ which they provide.

There are, however, one or two questions of a more simple nature suggested by Prof. Turner's notes for the answering of which I should in the meanwhile be thankful. One of our chief astronomers lately told me that a distinguishing feature of the cœlostat is that its polar axis lies in the plane of the reflecting surface. With this agree the opening words of Prof. Turner, who describes the mirror as rotating "round an axis in its plane." But on p. 417, he speaks of the "one adjustment which "concerns us—the parallelism of the face of the mirror to the "axis of rotation." From this last it might be gathered that so long as the axis and mirror are parallel, the former may be behind the latter. Possibly this is a small inadvertence on the Professor's part, but an explanation would be welcome.

Reading further down the page last quoted (417), it seems that the suspension of the mirror in its cell is in a very crude condition.

It is described as being "held in its place by three brass lugs "which are screwed up into a groove running round the edge." The mirror is elsewhere spoken of as being 16-in. diameter. What is its thickness? When it was necessary to adjust it, a

screw was gently screwed against it from behind, but on the subsequent removal of the screw the mirror did not fall back into its former position, *i.e.*, it seems to have stuck! Well, indeed, I should imagine, does the Professor add that the arrangements for this adjustment need further investigation. Fancy a speculum mounted in this way!

It is sometimes advantageous to erect the cœlostat on or near to the ground. Some of us can speak with peculiar feeling of the dorsal contortions experienced in observing a star in the zenith for adjustment of altitude of polar axis even when the telescope is at a respectable height. For the cœlostat I suppose that we must make up our minds to lie at full length to observe with the declination theodolite.

My reason for the hope expressed above that we may see an explanation of the instrument accompanied by illustrations is that there appears to be a limited number of cœlostats in existence, and those for various reasons practically inaccessible. It would also be well if the difference between the cœlostat and the heliostat could be explained. I can find no mention, not only of the former, but even of the latter, in any of the text-books in my possesion.

CHARLES D. P. DAVIES.

9 March 1900.

Egyptian Astronomy.

Though tradition has imputed to the ancient Egyptians a great knowledge, yet to some modern writers it has appeared that there are few or no grounds to justify this, at least in so far as astronomical science is concerned, and what there is in the way of record does not seem to have been too well understood. This may not improbably be due to the Egyptian priests having regarded their knowledge of astronomy as an esoteric and mysterious doctrine, and, therefore, one which they communicated only under promise of secrecy, and were very reluctant to disclose to foreigners or other curious inquirers; and the same remarks will also apply in regard to the Assyrians.

An instance in point is that cited by Diogenes Laertius, who informs us that, according to the Egyptians, 48,863 years had elapsed from the time of Vulcan to the arrival of Alexander the Great, and that during this period there had occurred 373 eclipses of the sun and 832 of the moon.

Such a statement sounds by no means credible, for it either seems fictitious, or else at the least it must involve something which has not hitherto been understood—because the given numbers would imply that there was only one eclipse of the sun in 131 years, and one of the moon in 58 years; whereas there may be a solar eclipse once in 2·18 years, and a lunar eclipse once in 1·04 years at a mean, above a fixed horizon. Such considerations have caused the whole to be treated as fabulous, and set aside as of no astronomical value, but so cursory an examination appears by no means sufficient when we are attempting to unravel the intentional mystifications resorted to by the Egyptian and Chaldean priests.

Moreover, there is a circumstance which seems to justify a further examination in this particular case, for it is somewhat singular that the proportion of solar to lunar eclipses quoted is very nearly correct for a given horizon within a certain time; and it has been said by a competent authority that such a coincidence certainly cannot be accidental. In view of this opinion it may not be unreasonable to make some further attempt to elucidate this Egyptian puzzle, for it does not appear impossible to arrive at its true meaning.

To begin with, the number quoted as supposed to represent a period of years, may not have been exactly given, as in the case of the "Great Year" cited by Cicero, which some writers quote as 12,854 years, and others as 12,954. A similar error seems to have crept into the number given by Laertius, which apparently ought to be 48,763, not 48,863, as will become evident.

Again, it will be necessary to remember that Eudoxus, according to Proclus, stated that the Egyptians sometimes designated a *month* by the appellation of a year, and by some of the later chronographers to have given the same name even to a day; and the Aristotelian commentator Simplicius, who wrote in the sixth century, says that the Babylonians had a period which they called 1,440,000 "years." These "years" may also require another name to be given to them.

Comparing these things, we easily arrive at a curious discovery, which appears to throw some light on the matter we are dealing with. For if we suppose that the Chaldean period cited by Simplicius represents days in place of years, while the Egyptian period quoted by Diogenes Laertius refers to lunar synodic months in a similar way, we shall find that both are just equal to 4,000 Egyptian years of 360 days each. The numbers, therefore, mean that in 1,440,000 days there were 48,763 mean lunations and 4,000 Egyptian years, and this we shall find comprises 985,626 Sothiac, or Canicular periods, of 1,461 days each, or 3,942,505 Julian years.

This may be sufficiently remarkable, but it is not all that was intended; for it will not quote the correct number of eclipses. Elsewhere in this "Journal," (Vol. VI., No. 10, p. 492), I have shown that in 1,000 Julian years there are 1432·171 eclipses above a given horizon; of which 957·76 are lunar, and 474·41 solar. It is therefore evident that the number of eclipses quoted by Laertius are only equivalent to about a quarter of the time we have derived from his record.

This difficulty disappears if we suppose that instead of 985·626 Canicular periods or "great years of the sun," the Egyptians meant us to understand, in reference to the eclipses, the same number of Julian years, and, further, that they omitted all lunar eclipses of half a digit and less, and all solar eclipses of one digit and under. Both would probably escape observation unless very carefully looked for, and would be quite unnoted by the multitude. Again, let it be granted that they omitted all eclipses which began a quarter of an hour before setting, or ended a quarter of an hour after the rising, as we not infrequently do at present.

Then in 985·626 Julian years we should have 829·28 lunar eclipses where the Egyptians quote 832, and 373·42 solar eclipses where they give 373. Thus, there would in all be 1,202·70, as against 1,205 recorded; and a much less degree of accuracy would be surprisingly near, seeing that we are testing by averages only.

Having thus explained all the numbers so far, we may next enquire between what dates these eclipses were probably noted, since the time appears to be ascertainable. Alexandria was founded B.C. 332, which is J.P. 4,382; from which, taking 985 years, we reach J.P. 3397. And in that year, on September 16th, O.S., which is Thursday the 4th, according to N.S., there was a new moon, which was also an eclipse of the sun, but not visible in Egypt; for it appears to have been central at noon in latitude 33° S., longitude 6° E.; the ecliptic conjunction occurring $15^d\ 23^h\ 57^m$ in G.M.T., the moon's latitude 38′·7 S. At the same time the true geocentric places of the sun and planets were as under.

	Sign.	°	′		Sign.	°	′
Neptune -	7	3	58.	Uranus -	3	12	52
Saturn -	5	22	16.	Jupiter -	5	19	4
Mars - -	3	21	9.	Venus -	5	11	33
Sun - -	5	11	28.	Mercury -	5	25	17

Thus there was an approximate conjunction of the sun, moon, Saturn, Jupiter, Venus, and Mercury, in the sign Virgo, and among the stars of that constellation, a configuration notable among the Egyptians, as I have tried to show in a previous article. As the ancients believed in the possibility of a general conjunction of all the planets, while apparently no such position has ever been recorded, I suspect they were in the habit of finding the nearest approach thereto, and then dividing the angular distances of the planets from the sun by 10 or 12, to produce what was required for mystical purposes.

By the above it appears that the statement of Laertius about the Egyptians and their eclipses, instead of being a mere fiction and entirely worthless, is capable of an explanation which is quite in accordance with the mystical spirit of ancient astronomy. And in any case the numerical coincidences, if not thought to amount to a demonstration, seem too many and too circumstantial to be the result of mere accident. Whether they will accord also with the value set upon the scientific attainments of the ancients by modern investigation, is another question, and may be left to individual opinion.

SAMUEL STUART.

View Road, Auckland, N.Z.,
January 2nd, 1900.

The Apparent Enlargement of Heavenly Bodies.

In the multitude of counsellors, we are told, there is wisdom, and so some grains of truth may be gathered from a multitude of theories. Be this as it may, it is my only excuse for contributing to this discussion.

In the first place it will be of use to consider by what process we arrive at an estimate of the size of terrestrial objects. The eye gives primarily information as to angular magnitude, and it is only by an approximate knowledge of the distance of the object observed that we can translate the angular magnitude and get some idea of actual size. Now this knowledge of distance is derived from experience, and each individual, taught by his experience, will form a scale of his own by which he estimates the size of the objects he sees. This scale is not measured by inches, or by any other conscious unit, but, though unconscious, it is sufficient to enable us to compare the size of one object with another. What is important is that the scale of magnitude depends on an estimation of distance, and that this is gained by experience.

Next consider the conditions under which this experience is gained. These will be different for different individuals. The sailor's experience is different from the landsman's. The atmospheric conditions in this country are different from those in, say, Switzerland. Therefore, we should expect that if we are placed under conditions different from those in which our experience has been gained, our estimates of distance, and consequently of magnitude, will be at fault. A few instances may be given of the effect of altering these conditions :—

1. Distances by sea are almost always deceptive to the landsman. By land we estimate the distance of an object by reference to a tree, or house, or hill, whose distance we already know. At sea there are no such landmarks, and consequently we find ourselves at fault.
2. Make a careful estimate of the size of any near object, and then suddenly look at it with one eye through a tube, and it will appear smaller. Whether this is due to the tube, or to the fact that only one eye is used, is immaterial. The difference in size is accounted for simply by an erroneous estimate of distance resulting upon changed conditions.
3. Travellers from this country to Switzerland commonly report a sense of disappointment at their first view of the Alps. The reason is well-known. The air of Switzerland being much clearer than ours, the mountains appear much nearer than they really are. The distance being thus under-estimated, the size is also under-estimated. Our experience has been gained in a country where the atmosphere is moisture-laden, and we are, therefore, at fault when we observe in a dry one.
4. It is well-known how objects loom large through a fog. This is the converse of the preceding case. The clear air gives the impression of nearness, compared with a foggy atmosphere which increases our estimate of distance. Either in Switzerland or in a fog, our estimates will soon be corrected by further experience, but a sudden change from one condition to the other involves mistaken estimates.
5. You show Jupiter through your telescope to a friend who has never observed in that way. You tell him that he

will see Jupiter as large as the moon is to the naked eye. He is disappointed. He expects something the size of a plate, and he sees an image no bigger than a sixpence. The reason is plain. He knows the moon to be far off. He thinks the image of Jupiter somewhere inside the telescope. Consequently, though the angular diameters be the same, he says Jupiter is the smaller, because he thinks it nearer.

These examples show how an alteration of the conditions of observation upset our calculations. So long as we confine ourselves to the same conditions our observations will be consistent, as tried by our unconscious scale; but if we compare magnitudes estimated under one set of conditions with those estimated under another set, we shall have anomalies. Further, of two bodies of equal *angular* magnitude, that which appears to us to be nearer we think the smaller.

When we come to consider celestial objects, it will be at once evident that the conditions of an observation near the horizon are not the same as when we observe near the zenith. The differences are probably numerous, but two seem to be of great importance.

In the first place, when observing near the horizon, we are aided in our estimate of distance by all our usual landmarks, whereas, in looking upward, there is nothing to guide us. In another case, we are also deprived of these landmarks, namely, at sea; and here distance is almost invariably under-estimated. By analogy, therefore, we should expect the distance of objects observed at high altitudes to be under-estimated when compared with observations near the horizon. Several Members have, indeed, stated that the sky appears to them elliptical, without, however, suggesting any reason for the appearance. Apparent enlargement at the horizon is the natural result of this different estimate of distance. It will be noticed that the contrast of conditions between horizon and zenith in this respect should not be so marked at sea as it is on land, and it would be interesting to know whether the apparent enlargement is as marked at sea as it is on land, other conditions, of course, being the same. According to this theory it should not be so.

The other cause of difference I take to be atmospheric. We have already seen that a clear atmosphere (the case of the Swiss mountains) conduces to an under-estimate of distance, and, therefore, of magnitude, while a fog produces an over-estimate of both. Zenith observations are analogous to the former, and horizon observations to the latter. In the case of the zenith, we are looking through a thin veil of atmosphere, while, at the horizon we are looking through a thick one. This cause also, therefore, makes us over-estimate the distance at the horizon as compared with the zenith, and we have apparent enlargement. Two facts may be noticed as showing the action of the atmosphere. Firstly, the apparent enlargement at the horizon is most pronounced when the horizon is specially hazy, and, secondly, on a very clear night the moon at a high altitude looks smaller than she does, even at the same altitude, when the atmosphere is less transparent.

JOHN TURNER, M.A., B.Sc.

The Apparent Enlargement of Heavenly Bodies.

The apparent enlargement of the sun and moon when near the horizon is purely illusory. This I made clear to myself by three experiments, which I will briefly describe :—

(1.) One day, while standing on a high railway bridge, waiting for a train, I gazed at a deep blue enamelled disk inscribed with an advertisement; the said disk was on a wall about 25 feet away from me. I then looked high up at the sky, and saw a greenish-yellow image of the disk of the same diameter as the disk on the wall. It then occurred to me to bring my eyes down so as to look at the far distant horizon; and immediately the yellow image expanded into a circle of far greater size than it was before.

(2.) One evening, on chancing to see the full moon just above the horizon, I performed another experiment, but in reverse order. I gazed for some time at the moon, which was like a great disk of brass. Then I looked high up in the sky, and saw a deep-bluish image of the moon, but very much smaller, I believe, than the moon at the horizon.

(3.) This morning I gazed at a small metal disk held at arm's length against the sky. Then I removed the disk, and saw a light circular spot in the sky. Again I looked at the disk as before, and again removed it, but looked this time at the horizon; and the light round patch expanded into a much larger circle than before.

These three experiments, therefore, made it plain to me that the enlargement of the sun and moon at the horizon is illusory.

As to the *cause*, I have thought that the following may, perhaps, be a possible explanation :—When we look at the moon high up in the sky we have not the same sense of distance as when we see it near the horizon ; it looks further off in the latter position. And because it subtends the same angle to us in both positions we unconsciously regard it as larger at the horizon, and therefore it seems larger.

January 8, 1900. JOSEPH ALLEN.

The Apparent Enlargement of Heavenly Bodies.

So little science has been brought into the discussion of this question that the elucidation has not advanced beyond where it was left at the October meeting. I propose, therefore, in this paper to consider the question according to the laws of light, and endeavour not only to explain the cause, but also why, the moon must appear larger when rising than when at the zenith.

Firstly, we must thoroughly understand under what conditions the moon does appear enlarged when on the horizon, because it is not at all times so evident. This is mostly the case when, after a hot clear day, there is a considerable amount of evaporation and condensation at sunset. The enlargement is then

most observable at sea, as we then see the moon at rising (the full moon is the more evident) through a greater depth of atmospheric conditions, and then there is nothing to affect its apparent size, or lead us astray, by comparison with other objects, and its size is affected more or less solely by the action of its rays on and through the heavily charged moist atmosphere of condensation.

It is only repeating common knowledge, but it is advisable to make the statement, that when rays of light pass through air laden with particles of moisture they are refracted and reflected. These different angles—which follow well understood laws—have the effect of causing the ultimate ray to assume the various colours of the spectrum. The action is similar to the formation of the rainbow, with this difference, that the angles of reflexion which form the entire bow are various, whereas in the case of the moon we have only to deal with the reflexion the light makes with the particles of moisture as seen at the level of the sea. The consequence is that we only see the *red* ray of the spectrum, and it is because the red ray is the least refrangible that the ruddy moon appears larger than the bright moon at the zenith, where it emits a white light, and, therefore, parallel rays.

As the consequence of refraction alone we do not see the moon, or any other celestial body, where it really is, so by the reflexion of the rays, the edges—and necessarily the whole body—are extended by the angle made by the rays before reaching the eye. We do not see the moon as it really is, but where the angles of reflexion make it appear to be, and the combined effect of these refracted and reflected rays is to increase the apparent size of the moon. Diagrams would make the matter clearer, but if the theory I advance is not absolutely acceptable, I hope it will tend to have this question argued on a scientific basis.

26 February 1900. JAS. D. HARDY.

Telescopic Focus for the Moon.

I shall be grateful for information on the following matter:— I find (and friends confirm my observations) that a point, on or near the limb of the moon, requires a focus appreciably different from that of a point at the centre of the disk. Will observers kindly state whether, after focussing clearly for a bright point on or near the limb, they have to move the eye-piece *in* or *out* in order to focus clearly for the bright centre of the disk, both points being viewed at the centre of the field? I shall be glad also to know the distance that the eye-piece has to be moved, and the reason for the alteration of the focus. It will be well to state the magnifying power used, and whether the focus for a star agrees with either of the foregoing foci.

Leeds, 20 February 1900. C. T. WHITMELL.

P.S.—Observing, on 10th March, the moon (nine days old, altitude nearly 60°), I could detect no focal difference between the centre of the disk and any part of the limb. This result makes my former observations still more difficult to explain. Powers ranging from 50 to 250 were used on a three inch refractor.

Jupiter apparently Moonless.

In my paper ("Journal," Vol. IX., pp. 376–8) I instanced 22 March 1874 as a date upon which, according to the "Nautical Almanac," Jupiter should be for 1^h 53^m apparently moonless, the civil time of the occurrence being from about 7 a.m. to 9 a.m. But, as the planet was then below the horizon for England, I could quote no observation of the phenomenon. It is, therefore, with much pleasure that I find that Prof. Todd, at Amherst College Observatory, Mass., saw the planet on 21 March apparently moonless for nearly two hours. (C.f., his recently published and deservedly popular work, "Stars and Telescopes," p. 123.) As Amherst is nearly five hours west of Greenwich, the local time of the observation would be from about 2 a.m. to 4 a.m. on 22 March 1874, *i.e.*, from 14^h to 16^h, astronomical time, on 21st.

Leeds, 17 February 1900. C. T. WHITMELL.

Observing Weather in Portland.

1899.	1.	2.	3.	4.
January - -	1	6	9	15
February -	2	7	3	16
March - -	7	5	7	12
April - -	1	6	5	18
May - -	6	5	9	11
June - -	5	5	10	10
July - - -	5	9	8	9
August - -	8	8	9	6
September -	6	4	8	12
October - -	1	9	12	9
November -	2	0	7	21
December - -	1	5	8	17
Totals -	45	69	95	156

August was the best month for observing, having 16 fairly good nights, March comes second, having 12.

As there were 251 unfavourable nights during the year, leaving only 114 on which work could be satisfactorily done, 1899 must on the whole, be pronounced unfavourable for amateur work, which is chiefly accomplished in the evenings, and it is noteworthy that the skies of the 45 evenings of the No. 1 column, did not generally arrive at their best until after midnight.

It is hardly necessary to explain the meaning of the numbers at the head of the several columns as it has been done so frequently in previous years.

It may be remarked that sea fogs have been unusually frequent at Portland during 1899; this would somewhat lower the totals as comparable with inland stations.

February 1900. W. R. WAUGH.

Astronomical Publications.

The Solar Parallax.—In "Comptes Rendus," Vol. 129, pp. 986–993, M. Bouquet de la Grye discusses the visual observations of the Transit of Venus in 1882 made by the French expeditions. It is found that the time of external contact is influenced by the size of the telescope, that of internal contact is not affected. The values of the parallax obtained are 8″·7996 from large telescopes, 8″·8068 from small telescopes, the mean being 8″·80. The photographic results are not yet known (P.A., February.)

The Total Solar Eclipse of 1900, May 28. *E. B. Frost.*—The Committee appointed by the Second Conference of Astronomers and Astro-physicists has endeavoured to ascertain the opinions of astronomers on the most important observations and the best means of making them. The replies indicate studies of the minute structure of the corona, both visually and by means of large scale photographs; photography of the flash spectrum and determination of the wave-length of the green coronal line; measurement of the heat radiation of the corona; photographic search for an intra-mercurial planet. There is every probability of a large number of observers with good equipment. A preliminary report on the weather conditions has been issued by the the Weather Bureau, and the full report, which will soon be published, will contain information as to towns, railways, hotels, and such matters. Interior stations present more favourable weather prospects than those nearer the coast. The Naval Observatory will issue instructions to observers, and a map of the eclipse track will be published by the Nautical Almanac Office. Instruments of foreign parties will be admitted free of duty. (P.A., February.)

The Relation between the Periodic Changes of Solar Activity and the Earth's Motion. *J. Halm.*—Wolf has shown that there are two well-defined periods of sun-spot development, the first about 11 years, the second nearly six times as long. This "great" period had minima near the middle of last century, in 1816, 1861, and 1888, with maxima in 1783, 1838, 1873. If the earth were subject to no other forces than the gravitational effects of the sun, moon, and planets, the "secular variation" should cause a small decrease in the obliquity of the ecliptic proportional to the time. Greenwich observations, however, show decided maxima and minima in this rate of decrease, and the turning points agree almost absolutely with the maxima and minima of the "great" sun-spot period. By introducing into Leverrier's formula a term depending on this period, the observed and computed values are brought into almost absolute coincidence. The variations of all the other elements of the earth's orbit exhibit well-marked periodic fluctuations agreeing closely with those of the "great" sun-spot period. The influence

of the 11-year period may be traced in the variation of latitude, every sun-spot maximum is followed after an interval of about 1·5 years by a minimum amplitude of variation, a sun-spot minimum being similarly followed by a maximum amplitude. Newcomb found great difficulty in deducing the solar parallax from the secular variations of the node and obliquity of Venus, but by eliminating the effects of this new solar force a result $\pi = 8''\cdot802$ is deduced, which accords well with those obtained from other sources. It has been suggested by Mr. G. Clark that the new force may be connected with variations in the earth's magnetism, these causing molecular displacements in the direction of the magnetic axis. (**Nat.**, March 8.)

THE COMING ECLIPSE OF THE SUN. *E. Walter Maunder.*—Information regarding the path of the eclipse, the altitude of the sun, and the probable weather conditions at various stations along it, together with particulars of the distribution of the English official parties, are given in this paper, which is illustrated with two maps showing the line of totality in Spain and America. Attention is drawn to the fact that observations of the shadow bands and the visual study of a small portion of the inner corona have received very scanty attention during recent eclipses. (**Kn.**, March 1900).

THE STRUCTURE OF THE INNER CORONA. *S. P. Langley.*—Prof. Langley observed the inner corona for a few seconds with a 5-inch achromatic, in 1878, from Pike's Peak. He was struck with the extraordinary sharpness of the filamentary structure, the arrangement of which was not radial and the lines not straight, but curved in different directions; it was very bright close to the edge, but faded rapidly and was wholly lost at from 5′ to 10′ from the edge. He thinks that even the best photographs yet obtained have not done justice to it, and hopes that whenever possible it may be made the subject of telescopic visual study. (Nat., March 8.)

LUNAR CHANGES DURING THE ECLIPSE OF 1899, DECEMBER 16. *W. H. Pickering.*—The seeing at Cambridge, U.S.A., was very good, and Riccioli, Schröter's Valley, the plain W. of Webb, and Linné were observed with the 15-inch equatorial for possible change. None was noted in the first three formations. During the eclipse of 1898, December 27, the seeing was very bad at Cambridge, but Mr. Douglass, at Flagstaff, had observed Linné from December 25 to 29, and wrote, "I should say that the crater "was smaller on the 27th than on the other four nights, but "exhibited slight increase of size for 30 minutes after totality." The minor axis of the white spot about Linné two days after sunrise is 4″, by the eighth day it reaches a minimum at 2″, and two days before sunset it has increased to about $3''\cdot5$. Careful measures were made of this diameter on December 13, 15, and 16, the 5th, 7th, and 8th days after sunrise. Those on the 13th and 15th were decidedly larger than those on the 16th, and although the result is not conclusive, the measures tend to confirm Mr. Douglass' observation that there was an enlargement, and that it was of short duration.

As, then, there is strong reason to believe that the size of Linné increases as the sun approaches its horizon, it seems natural to suppose that it should increase when the sun's light is withdrawn altogether. (P.A., February.)

THE DETERMINATION OF SELENOGRAPHIC POSITIONS. *S. A. Saunder.*—A personal equation is known to exist in observations of the moon's limb, and no indication of the error due to this cause is given by the probable error of a series of measures obtained from those measures themselves. A great difficulty also of measuring from the limb has always been recognised, and it has therefore been suggested that transits of a well-defined formation as Mosting A. should be observed in preference to transits of the limb. Prof. Turner has suggested an elegant method by the use of rectangular co-ordinates for facilitating the computation of the correction of measures for libration. Mr. Saunder proposes to apply the method he advocates to the measurement of lunar photographs. (M.N., January 1900.)

MERCURY AS A NAKED-EYE OBJECT. *W. F. Denning.*—There is considerable doubt whether Copernicus ever complained of failure to see Mercury, but if the story is true, a reason may be found in the frequent fogs from the Vistula, which ran close to his residence, obliterating objects near the horizon. An observer with good sight might, in our climate, see it on about 12 occasions in a year, more frequently in a finer climate. Observations by the writer extending over a number of years show that the greatest brightness is attained 10 or 12 days before greatest eastern elongation. In February and March it may be caught 20 minutes after sunset, in April 30 minutes, and in May 40 minutes, the duration of visibility to the naked eye being about $1^h 40^m$ in March, $1^h 30^m$ in April, and $1^h 20^m$ in May. It is certainly much brighter than a first magnitude star, and in February 1868 its lustre vied with that of Jupiter, then only 2° or 3° distant. Its albedo is very low, only 0·11, that of Mars being 0·27, Saturn 0·50, Venus and Jupiter 0·62. It has probably only a thin atmosphere, and whilst there are undoubted markings visible, they are nothing like the peculiar figures that have been published during the last two or three years. The difficulty of obtaining satisfactory views is the principal reason why its rotation period is not yet accurately known. (Nat., March 1).

THE EXTRA-EQUATORIAL CURRENTS OF JUPITER IN 1899.—*Rev. T. E. R. Phillips.*—Mr. Phillips draws attention to the abnormal velocity exhibited by several spots on the N. tropical zone. He describes the dark spots as frequently appearing double, both components of the ball being intensified and united by dusky shadings. In a few places distinct white spots were observed, which, however, did not move at anything like a uniform rate. In certain longitudes the N. equatorial belt was much disturbed and broken up along its N. edge by a series of light and dark spots. The Red Spot was exceedingly faint and difficult, appearing to the writer grey. The "red spot hollow" exhibited a striking irregularity of motion. In the S. temperate zone the spots differed considerably among themselves, and individual velocities varied from time to time. (M.N., January 1900.)

OBSERVATIONS OF METEORS AT ROYAL ALFRED OBSERVATORY, MAURITIUS, 1899, NOVEMBER.—*T. F. Claxton.*—It is probable that the maximum Leonid display occurred after sunrise (day not specified). Until 2 a.m. on the 14th the sky near the radiant was occasionally covered with thin misty cloud. The zodiacal light was observed on the 14th and 15th. The axis of the cone at 2.30 on each morning appeared to extend from α Leonis along a parallel of declination to the horizon keeping at an approximately constant altitude. No pink tinge was distinguishable. (M.N., January 1900.)

STATIONARY METEORIC RADIANTS. *W. H. S. Monck.* — Mr. Denning's researches on meteor radiants seem to place beyond doubt that in most cases they are stationary. Is there sufficient reason to believe that they are not all so, whatever may be the cause of so surprising a phenomenon? Of the Lyrids Mr. Denning is uncertain. With regard to the Perseids, a careful examination of the track their radiant is supposed to pursue shows that it is entirely within the space covered by a number of stationary radiants, all of which are active at the time the supposed shifting radiant is said to overlap them, as well as before and after; the point from which the chief Perseid shower emanates is also active in a less degree before and after August 10 and 11; moreover it is not contended that the Perseid meteors are physically distinguishable from others. In this case, therefore, where the evidence for a shifting radiant is considered the strongest, it may just as well be apparent as real, and no exception to the rule of stationary radiants has been established. (A.S.P., December 1899.

ZODIACAL LIGHT. *Mr. F. J. Bayldon* has made numerous observations of the zodiacal light as seen in the Pacific Ocean, especially during the past year, when voyaging between Sydney and Vancouver. He finds that the eastern and western cones may be seen every clear morning and evening when the moon is in her first or last quarter, while on very clear moonless nights the Light is seen all night as a band stretching across the whole sky. It is inclined about 4° to the plane of the ecliptic, crossing the latter in R.A. 0^h and 12^h. The line of central axis is slightly displaced to observers moving N. or S. The band is uniformly about 22° in width, the appearance of cones being due to atmospheric effects which are greatly exaggerated in extra-tropical regions. The elliptical portion known as the Gegenschein, which is usually, especially at the solstices, brighter than the surrounding part, seems to vary in position from 2° or 3° E. to the same amount W. of the anti-solar spot. In colour the band is a soft white, and at 105° from the sun it frequently exceeds in brightness the Milky Way. The cones are sometimes so bright that no star fainter than second magnitude can be distinguished in them. (A.S.P., February, 1900).

VARIATION OF LATITUDE. *Frank Schlesinger.* — The programme of the International Geodetic Association for determining variations of latitude is now being carried out at the four stations Mizusawa (Japan), Carloforte (Italy), Gaithersburg (Maryland),

and Ukiah (California). These are all within a few seconds of the same parallel of latitude. Cincinnati Observatory happens to be only a few hundred feet north of the same parallel, and the director has volunteered to take part in the work. The Russian Government has also promised to equip and support a station at Tschardjui, which is in longitude 64° E., on the River Oxus, and therefore comes in conveniently between Carloforte and Mizusawa. The observing list contains 96 pairs of stars, from the 4th to the 7th magnitude, and each of the four stations is equipped with a similar zenith-telescope of 4¼-in. aperture. (**A.S.P.**, December 1899.)

SOME REMARKABLE SPECTROSCOPIC BINARIES. *A. M. Clerke.* —Capella is one of the few spectroscopic binaries at a determined distance from the earth, its carefully revised parallax of 0″·08 being equal to a light journey of just forty years. The joint volume of the components, if they are equal globes of solar intrinsic brilliancy, can be no less, in round numbers, than one thousandfold that of the Sun, and their joint mass ought to be even proportionately greater. But when we come to consider their motions we are met, at first sight, by a very different result. They travel with a relative speed of 36 miles a second, in a period of 104 days; which gives for their orbit, on the hypothesis of a plane passing through the earth, a radius of 51½ million miles, and implies for the system a mass 2⅐ times the solar. But we are free to select any plane for the revolutions of the conjoined stars. If, indeed, their mass actually matches their lustre, they are moving almost vertically, the deviation from perpendicularity not amounting to 6°. If this be so, their real velocity is ten times greater than their measured velocity, and their actual orbit ten times more spacious than their measured orbit.

A pair in some respects resembling Capella is met with in o Leonis. The period of oscillation is 14½ days, the relative velocity 73 miles a second, whence an orbital radius is deducible of 14½ million miles (as projected on the visual plane), and a systematic mass 2½ times that of the Sun.

The spectrum of β Capricorni combines the peculiarities of a mixed Sirian and solar type, and of variable radial velocity; but no further details are at present forthcoming. Recent investigation of the binary character of ζ Centauri has proved that the maximum separation of the lines occurs at intervals alternately of two and of six days. Thus the revolutions of the pair are accomplished in a period of eight days, so unequally divided that about one third of the time spent in describing the apastron section of the ellipse suffices for the wheel round periastron. (**Obs.**, March.)

PACKING INSTRUMENTS FOR TRANSPORTATION. *Sabra C. Snell.* — Prof. Todd's experience is that the safest packing material is cork sawdust, packed in cotton bags, stitched and filled nearly as hard as a pincushion. The cork may be obtained from any dealer in Malaga grapes, it should be well washed in lukewarm water, when the dirt usually sinks, whilst the cork floats. It may then be skimmed off and carefully dried. (**P.A.**, February.)

SPECTROSCOPIC BINARY STARS. *R. G. Aitken.* — These may be divided into three classes, viz., 1. Algol-type. 2. Those which periodically double their spectral lines. 3. Those in which the lines are alternately displaced toward the red and the violet. Up till January 1898 by far the greater number known belonged to the first class, for they numbered 14, while there were only five of the second, and two of the third. Since then, however, though only three have been added to the first and none to the second, 17 of the third type have been discovered, of which 14 are due to Campbell, and three to Belopolsky. Before 1898 only one spectroscopic binary was known with a period exceeding 10 days, (viz., ζ Ursæ Majoris), but of those found recently several have periods of some months, and one, η Pegasi, $2\frac{1}{4}$ years. There is, therefore, no longer a gap in this respect between the spectroscopic and the visual binaries. The proportion of the former to the stars whose velocities in the line of sight have been well determined indicates that they are at least as numerous as the latter. (A.S.P., December 1899.)

DOUBLE STARS. *Mr. Aitken,* at the Lick Observatory, obtained measures of 255 close double stars during the past year, many of which were near the limit of the separating power of even the 36-inch refractor. The periods of revolution of β 883, and of φ Andromedæ seem to be greater than was at first supposed. In the first half of 1898 OΣ341 appeared perfectly round, even with high powers, towards the end of the year it appeared elongated, and it will soon be a comparatively easy double for large telescopes under good conditions. Accurate measures at frequent intervals will be useful for determining the orbit. The velocity of β Herculis in the line of sight has been found variable, and the period of this spectroscopic binary would seem to be about a year. (A.S.P., February, 1900).

THE METHODS OF INORGANIC EVOLUTION, II. *Sir N. Lockyer.* — Complex substances might be built up by polymerisation, or the coming together of similar atoms, but they might also be built up by the coming together of dissimilar atoms, and the analogy of known chemical compounds is in favour of the latter view. Physicists now imagine molecules built up of sub-particles called ions, each with electric charge e and mass m, moving in an elliptic orbit, and each a complex dynamical system, the motions of which are registered in the spectrum. If the light source is in a strong magnetic field, these orbits will undergo a precessional spin the amount of which is measured by e/m. Dr. Preston has shown that in metals of the same chemical group, as in cadmium, zinc, and magnesium, the spectra of which contain triplets, the value of e/m is the same for the ions producing the first line of each triplet, not only throughout the spectrum of one metal, but that it has the same value in the first line of each of the other metals, similar relations holding for the second and third lines. This suggests that although the wave-lengths differ from one metal to the other, we may have the same ions in the different metals associated with different centres of force. When kathode rays are deflected in a magnetic field the deflection depends upon

the ratio m/e for the particles acted on. Prof. J. J. Thomson and Mr. Townsend have shown that whilst e is the same as for a hydrogen ion, the ratio m/e has about $\frac{1}{700}$ of its value for hydrogen, so that the mass m is about $\frac{1}{700}$ of the mass of the hydrogen ion, and that when the subdivision is carried to this extent, all matter, whether derived from oxygen, hydrogen, or other source, seems to be of one and the same kind. These views confirm those derived from the study of stellar spectra, the ions visible in the spectra of the hottest stars being those associated with the smallest centres of force, larger aggregates of material units in the centres becoming possible as the star cools. (**Nat.**, January 25.)

GROWTH OF A GREAT AMERICAN OBSERVATORY IN TWENTY YEARS. *E. C. Pickering*—(Report to Board of Overseers of Harvard College, May 1899.) When Prof. Pickering was appointed to the Harvard Observatory in 1877 he urged upon the Visiting Committee the great increase in efficiency which might be secured by a small addition to the income. The matter was well taken up, and the income from invested capital has risen from \$14,359 in 1877 to \$46,175 in 1898, although the rate of interest has fallen 2 per cent. The observatory now has a permanent station at Arequipa, which enables researches on the northern stars commenced at Cambridge to be continued to the S. pole upon a uniform system, and, if desirable, with the same instrument. About 45,000 stars down to the 8th or 9th magnitude have been measured with the meridian photometer, and a more powerful instrument now enables stars of the 13th magnitude to be measured. A zone of 8,627 northern stars have been measured with the meridian circle, and the results published. Observations of a similar southern zone have been completed and are in process of reduction. Several photographic telescopes are in constant use at both observatories throughout every clear night, some 8,000 plates are taken during the year, and the collection of nearly 100,000 show the spectra of all stars in the sky brighter than the 10th magnitude, whilst as the whole sky is photographed several times a year, they contain a history of the visible universe for the last 10 years. A notable instance of their value is given by Eros, the path of which from 1893, October to 1894 May, is shown on 15 plates, each position being given with an accuracy equal to that of a meridian observation. These results have been obtained by a rigorous economy, nothing is spent on display, and appearances are sacrificed to efficiency, whilst the salaries of the younger assistants are not such as their services merit. In spite of this care, the continual reduction in the rate of interest causes a serious diminution in the funds available, and further endowment is necessary if the present work is to be continued. (**P.A.**, February.)

THE GREAT NEBULA IN ORION. *W. H. Wesley.*—In comparing the many drawings that have been made of this object since its discovery in 1618, one is principally struck by their extraordinary divergence. It is only too obvious that the vast labour of so many observers has for the most part done scarcely anything to advance our knowledge of the form of the nebula. Of course differences of instruments will account for some of the

divergences of the drawings, but it is evident that they are mostly due to a want of skill on the part of the draughtsmen. The best drawings are those of Bond and of Lord Rosse, which were the result of years of labour, but as real evidence for possible changes one good photograph would be far more valuable. And in view of the fact that the comparison, even of photographs, taken under different conditions is by no means easy, it seems likely that the supposed changes that have been deduced from drawings are really due to differences of atmospheric and instrumental conditions, and, above all, to the inevitable errors of observation. (Obs., March.)

ASTRONOMY WITHOUT A TELESCOPE. II. THE ZODIACAL LIGHT. *E. Walter Maunder.*—Keen eyesight, patience, and a small star-atlas are all the equipment that is required for zodiacal light-work. The principal points for observation are first the character of the evening. Then the extreme borders of the light should be mapped out, its position with regard to the stars noted, and the intensity of the light compared with a selected area of the Milky Way as a standard observed. Search should be made for the gegenschein, and it should be seen whether the light extends to, or is merged in it. The position of the apex of the light should also be noted. (Kn., March 1900).

A POSSIBLE CAUSE OF THE VARIABILITY OF STARS. *G. Johnstone Stoney.*—Prof. Bailey has shown (Ap. J., November 1899) that as many as 40 stars in the cluster M.V., nearly one-twentieth of whole cluster, are variables with periodic times, light curves, maxima and minima, which, though not the same, do not differ much from one star to another. These stars were probably originally nearly alike in physical condition, brightness, star-spot period, and period of internal dynamical vibration. If so, the resemblance would continue during their subsequent history, and it is suggested that in consequence of shrinkage the star-spot period and the period of internal dynamical vibration have become nearly equal; the effect would probably be to cause a considerable increase in the periodical development of spots, and the stars would become variable until further shrinkage destroys the adjustment. A simple numerical relation between the two periods would have the same effect, though in a less marked degree, and may account for the cases of those variables which have more complex light curves with several maxima and minima.

CERASKI'S SECOND ALGOL VARIABLE.—The Moscow photographs gave the period from an interval of four years. "Harvard Circular No. 47" states that by combining these with the Harvard records the interval is extended to nine years, with the result that the period is diminished by $0 \cdot 6^m$, giving $6^d\ 0^h\ 8 \cdot 8^m$. This differs so slightly from 6^d that for a long time the minima cannot be observed in certain longitudes. Observations of the minima may be obtained in Europe and Asia next autumn, but not in America until the year following. In this and four other stars of the Algol class the variation amounts to about two magnitudes. Two of these were discovered by Madame Ceraski and one by her husband. (Nat., March 8.)

Variable Stars.

Star.	Maximum.		Minimum.		References.
	Date.	Mag.	Date.	Mag.	
T Andromedæ	1899, July 28·5	8·8	—	—	A.J., 160.
S Antliæ	—	—	1899, Dec. $19^d 21^h 27^m$	—	„ 160.
R Aquilæ	—	—	„ June 16	10·6	„ 157.
S Bootis	1900, Feb. (end)	8·4	—	—	E.M., 78.
U Bootis	—	—	1899, July 17	—	A.J., 157.
T Cephei	1900, Jan. 24	5·2	—	—	E.M., 78.
R Herculis	1899, June 10	8·49	—	—	A.J., 157.
W Herculis	„ May 26	8·45	—	—	„ 157.
RS Herculis, A	„ Aug. 1	8·34	—	—	„ 157.
„ B	„ Sept. 4	7·97	—	—	„ 157.
„ B	„ Aug. 28	7·9	—	—	„ 157.
RT Herculis	—	—	1899, Aug. 15	13	„ 157.
RU Herculis	1899, July 3 (earlier?).	—	„ Oct. 7	—	„ 157.
R Libræ	„ June 21	9·10	—	—	„ 157.
S Libræ	—	—	1899, June 13	11·8	„ 157.
Y Libræ	1899, June 13	9·04	—	—	„ 157.
RS Libræ	—	—	1899, June 11	11·95	„ 157.
RT Libræ	1899, May 24	8·37	—	—	„ 157.
RU Libræ	1897, Mar. 16	—	1898, July 9	—	„ 157.
„	1899, Nov. 1	—	1899, May 25	—	„ 157.
S Lyræ	„ July 4	9·94	—	—	„ 157.
R Ophiuchi	„ Sept. 28	7·13	—	—	„ 157.
Z Ophiuchi	—	—	1899, Aug. 14	12·5	„ 157.
U Pegasi	—	—	„ Dec. $21^d 13^h 25^m$	—	„ 161.
R Scorpii	1899, June 5	10·6	—	—	„ 157.
S Scorpii	„ May 5 (later?)	10·1	—	—	„ 157.
W Scorpii	„ June 5	11·27	—	—	„ 157.
Y Scorpii (see below).	„ June 25 (later?)	11·0	—	—	„ 197.
R Serpentis	„ Sept. 12	7·16	—	—	„ 157.
S Serpentis	„ July 16	8·93	—	—	„ 157.
„	„ July 21	8·5	—	—	„ 157.
„	„ July 29	8·5	—	—	„ 157.
T Serpentis	„ Sept. 14	9·82	—	—	„ 157.
R Ursæ Majoris	—	—	1900, Jan. 24	12·9	E.M., 78.

Maxima and Minima of Long Period Variables, (P.A., 98.)

Maxima.

Star.	Mag.	Dec.	Star.	Mag.	Dec.
February.			**March.**		
R Ceti	8·2	1	*T Andromedæ*	8·0	16
R Reticuli	7	16	*S Ceti*	7·5	12
W Monocerotis	8·8	28	*R Sculptoris*	6·6	20
W Puppis	9·5	2	*S Arietis*	9·5	15
U Puppis	8·8	27	*R Persei*	8·5	22
l Carinæ	3·7	27	*T Eridani*	7·2	26
RR Hydræ	8·5	6	*S Tauri*	9·7	21
W Leonis	9	17	*V Tauri*	8·9	7
RR Virginis	11	27	*L Puppis*	3·5	14
RS Virginis	8·2	6	*U Monocerotis*	8·6	15
S Coronæ	7·0	28	*T Geminorum*	8·4	17
Z Libræ	11	23	*V Leonis*	8·6	28
X Herculis	6·1	17	*T Can. Venat*	8·7	31
W Scorpii	10·6	20	*T Ursæ Maj.*	7·3	14
R Scorpii	10	9	*R Virginis*	7.3	3
R Draconis	7·6	15	*T Centauri*	5·9	8
R Lyræ	4·0	9	*Y Libræ*	8·5	14
RX Sagittarii	9·9	7	*RU Libræ*	8·5	26
W Aquilæ	7·5	26	*U Libræ*	9	11
S Vulpeculæ	8·7	13	*RZ Scorpii*	7·8	18
Z Aquilæ	8·9	16	*W Herculis*	8·2	30
RR Cygni	8·4	5	*RS Herculis*	8·0	25
			T Herculis	7·7	24
			X Ophiuchi	7·9	7
			R Lyræ	4·0	27
			S Sagittarii	9·8	13
			RT Cygni	7·3	5
			R Sagittæ	8·6	18
			S Delphini	9·1	29
			V Cassiopeiæ	7·5	7

Minima.

Star.	Mag.	Dec.	Star.	Mag.	Dec.
February.			**March.**		
U Piscium	14·7	15	*T Sculptoris*	10·0	14
R Arietis	12	16	*R Tauri*	13·0	18
U Ceti	12	8	*X Puppis*	9·6	7
V Persei	10	8	*R Leonis Minoris*	13	8
R Geminorum	13·5	9	*e Carinæ*	5·2	21
V Geminorum	13	23	*S Carinæ*	9·1	17
U Monocerotis	7·1	25	*S Leonis*	<13	7
S Geminorum	<13·5	8	*X Centauri*	12·4	13
V Cancri	12	19	*U Virginis*	12·5	31
e Carinæ	5·2	13	*R Hydræ*	9·7	25
R Ursæ Maj.	12·9	23	*W Hydræ*	8·0	14
S Ursæ Maj.	10·9	8	*R Centauri*	9·3	27
RV Herculis	<15	12	*V Libræ*	12·2	20
W Capricorni	<14·7	24	*T Libræ*	<14·7	13
V Capricorni	14?	6	*X Herculis*	7·0	21
X Aquarii	13	25	*R Ophiuchi*	<12	27
S Lacertæ	<12	28	*W Lyræ*	12	18
			R Lyræ	4·7	5
			U Draconis	<13	15
			S Vulpeculæ	9·5	26
			S Aquilæ	11·3	18
			R Sagittæ	10·1	2
			W Cygni	6·4	11
			S Pegasi	13	6

Minima of the Variable Stars of the Algol Type.
(Given to the nearest hour G.M.T.)
(P.A., 100.)

U Cephei.

	d	h
Mar.	3	17
„	8	17
„	13	16
„	18	16
„	23	16
„	28	15

Algol.

	d	h
Mar.	11	18
„	14	15
„	17	12

λ Tauri.

	d	h
Mar.	8	17
„	12	16
„	16	15
„	20	13
„	24	12

S Cancri.

	d	h
Mar.	6	18
„	16	5
„	25	17

R Canis Majoris.
Every 3rd Min.
$P = 1^d\ 3^h \cdot 3$

	d	h
Mar.	3	13
„	6	23
„	10	9
„	13	19
„	17	4
„	20	14
„	23	24
„	27	10
„	30	20

S Velorum.

	d	h
Mar.	1	12
„	7	10
„	13	9
„	19	7

δ Libræ.

	d	h
Mar.	2	20
„	7	12
„	16	19
„	21	11
„	30	18

U Coronæ.

	d	h
Mar.	5	9
„	8	20
„	12	7
„	15	18
„	19	5
„	22	16
„	26	2
„	30	13

U Ophiuchi.
Every 4th Min.
$P = 20^h \cdot 1.$

	d	h
Mar.	2	0
„	5	8
„	8	17
„	12	1
„	15	10
„	18	18
„	22	3
„	25	11
„	28	20

W Delphini.

	d	h
Mar.	18	19
„	23	15

RS Sagittarii.

	d	h
Mar.	1	16
„	6	11
„	8	21
„	13	17
„	18	13
„	25	19
„	30	15

+ 12°3557.

	d	h
Mar.	6	21
„	7	19
„	8	16
„	14	21
„	15	19
„	16	16

+ 45°3062.

	d	h
Mar.	5	6
„	9	20
„	14	10
„	19	0
„	23	13
„	28	3

SS Cygni.—This remarkable star was normal December 29 at about $8 \cdot 6^m$ (P.A., 100). December 30·55 it was $< 11 \cdot 0^m$, and January 1·48 it had reached 8·78 (A.J., 161). Flannery gives (Kn., 39) his observations from November 21 to December 6, and Sperra (A.J., 160) from 1899, April 19 to 1900, January 7·58.

SU Cygni.—From 57 observations of this star Yendall gives (A.J., 171) the dates of 17 maxima and 11 minima, between July 1·08 and November 12·72. Following are those in November :—

Max.	-	Nov. 5·12	Min.	-	Nov. 4·33
„	-	„ 12·72	„	-	„ 8·57

Y Scorpii.—The period is probably 15 days either more or less than a year (A.J., 157).

U Vulpeculæ.—Yendell made 56 observations of this star (A.J., 171) from 1899, July 3·79 to Nov. 13·09. From these he has deduced the dates of 10 maxima and 11 minima. Following are those in October and November :—

Max.	-	Oct. 7·73	Min.	-	Oct. 3·00
„	-	„ 14·32	„	-	„ 10·32
„	-	Nov. 7·9	„	-	Nov. 4·8
			„	-	„ 13·09

Notices of the Association.

The ordinary Meetings of the Association will be held on March 28, April 25, May 30, and June 27, at Sion College, Embankment, at 5 p.m.

Editorial Change of Address.

The Editor asks Members to kindly note that his address in future will be—

Mr. E. WALTER MAUNDER, F.R.A.S.,
86, Tyrwhitt Road, S.E.

Queries.

It is requested that queries be written on one side of the paper only, and each query on a separate sheet.

Queries may either be placed in the Query Box at the Meeting, or may be sent to the Hon. Secretary, Mr. W. Schooling, F.R.A.S., Granville House, Arundel Street, Strand, W.C.

The Eclipse of 1900, May 28.

The Eclipse Committee regret to state that in consequence of R.M.S "Tagus," and her sister vessel R.M.S. "Nile" being requisitioned by the Government as transports, the negotiations with the Royal Mail Steam Packet Company for a steamer to convey a party of Members of the Association to Spain and Algiers to view the forthcoming eclipse necessarily came to a close. The Committee accordingly endeavoured to secure another vessel, but found it impossible to obtain one comparable with the "Tagus" in size and standing; and so many of the passengers who had booked berths in the latter vessel declined to accept a transfer in a smaller boat that the entire project for a steamer expedition had to be abandoned. The Committee, therefore, are unable themselves to undertake any arrangements for the journeying of the Members to places within the shadow track.

The following routes, however, suggest themselves:—

(1.) Lisbon (whence by rail to Ovar, Vizen, Guarda, or Plasencia), Royal Mail steamer leaving Southampton May 11, arriving Lisbon, May 14. Return steamer leaving Lisbon May 30.

(2.) Navalmoral, near Talavera, Spain. Overland tour, arranged by Messrs. T. Cook and Sons, Ludgate Circus, E.C.

(3.) Gibraltar, (whence by rail to Alcazar de San Juan), by P. and O. steamer.

(4.) Alicante, from Liverpool direct; MacAndrew line.

(5.) Algiers, overland tour, arranged by Messrs. T. Cook and Sons.

(6.) Algiers, from Liverpool direct; Moss or Papayanni lines.

It is hoped that all Members who go out to observe the Eclipse will send their names, full particulars of the instruments, and of the work they intend to undertake to the Assistant Secretary, 26, Martin's Lane, Cannon Street, E.C.; so that as far as possible the observations may be arranged in concert.

Candidates for Election as Members of the Association.

28TH MARCH 1900.

SIR THOMAS S. BAZLEY, Bart., M.A., J.P., D.L.,
Winterdyne, Bournemouth West.
Proposer—G. F. Chambers. *Seconder*—Jane Lassell.

OTTO HOFFMANN,
Budapest, V, Nádor utcza 12, Hungary.
Proposer—Leo Brenner. *Seconder*—E. Walter Maunder.

REV. AUGUSTIN MORFORD,
St. Mary's, Poole, Dorset,
Proposer—H. J. Barnes. *Seconder*—H. A. Lawton, M.D.

G. ROSSALL PEARSON,
Stafford House, Halifax.
Proposer—Joseph Gledhill. *Seconder*—E. Walter Maunder.

CAPT. FRANK WILLIAM RAISIN, R.N.R,.
6, Reservoir Road, Hatcham, S.E.
Proposer—W. Cooke. *Seconder*—J. G. Petrie,

DAVID CHISHOLM SIMPSON,
199, Camberwell Grove, Denmark Hill, S.E.
Proposer—David G. Simpson. *Seconder*—C. Thwaites.

New Members of the Association.

ELECTED 28TH FEBRUARY 1900.

ARTHUR C. BANFIELD, Teme Street, Tenbury, Worcestershire.

REV. W. H. BROWNE, Durham University.

CAPT. ALFRED CARPENTER, R.N., F.R.MET.SOC., The Red House, Sanderstead, Croydon.

MRS. ANDREW CROMMELIN, Benvenue, 55, Ulundi Road, Blackheath, S.E.

THOMAS WILLIAM FOINETTE, ASSOC.I.ELEC.ENG., 305, High Road, Lee, S.E.

WALTER HEATH, M.A., Redcot, Cobham, Surrey.

RICHARD JACQUES, M.I.C.E., Caldera, Chile.

MISS JUDITH LOUISE LEARMONTH, The Cottage, Northaw, Potters Bar.

WILLIAM ROBINSON, Balliol House, Wentworth Street, E.

REV. CHARLES J. STEWARD, F.R.MET.SOC., The Cedars, Anglesea Road, Ipswich.

CAPT. CHARLES RICHARD STEVENS, R.E., Grange Cottage, Netley Abbey, Southampton.

Additions to the Library.

Flammarion.—Popular Astronomy, translated by Gore.
Wallon.—Leçons d'Optique géométrique.

The Library Catalogue (including additions to the end of last Session) will be forwarded by the Hon. Librarian on receipt of 1*s.* 1*d.*

Published March 26, 1900

The Journal
of the
British Astronomical Association.

VOL. X. SESSION 1899–1900. No. 6.

REPORT OF THE MEETING OF THE ASSOCIATION, HELD ON MARCH 28, 1900, AT SION COLLEGE, VICTORIA EMBANKMENT.

W. H. MAW, F.R.A.S., *President*, in the Chair.

J. G. PETRIE, F.R.A.S.
A. C. D. CROMMELIN, F.R.A.S. } *Secretaries.*

The *Secretary* read the Minutes of the last Ordinary Meeting, which were confirmed.

The names of seven candidates for admission were read and passed for suspension, and the election by the Council of six new Members was confirmed.

The list of presents received included, from Sir Wm. Huggins, Vol. I. of his "Atlas of Representative Stellar Spectra." The Meeting passed a vote of cordial thanks.

The *President* regretted to have to announce that the Council had received a letter from Mr. Schooling, one of their esteemed Secretaries, intimating that, owing to pressing business engagements, he felt compelled to resign his office. All the Members would, he (the President) felt sure, share the regret which the Council felt at hearing of Mr. Schooling's resignation. They knew, however, that it was really meant, and that Mr. Schooling desired that it should be accepted. The Council had no option, therefore, but to accept this resignation. They had done so with regret, and had passed a resolution that a letter should be written by Mr. Petrie expressing the indebtedness of the Association to Mr. Schooling for the work he had done in connexion with his office, and expressing the hope that at some future time they might again have his assistance in an official capacity. He thought the Members generally would wish to share in this expression of indebtedness to Mr. Schooling, and would desire that in this matter their names should be added to those of the Council. There was plenty of work for the two Secretaries, and

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it was, therefore, necessary that the vacant office should be filled at once, and, having power to fill any vacancy that might occur during the session, the Council had appointed Mr. Crommelin in Mr. Schooling's place, having been so fortunate as to induce that gentleman to accept the office.

Mr. Maunder, upon being asked by the President to make a statement with reference to the arrangements for observing the approaching solar eclipse, said that shortly after the previous Meeting, the ship for which they were then in negotiation with the Royal Mail Steamship Co., the "Tagus," was requisitioned by the Government as a transport, and not only so, but her sister ship the "Nile" also, upon which it had been understood they were to fall back in case anything should happen to prevent their having the "Tagus." Under these circumstances, the Royal Mail Co. intimated that they could no longer guarantee that they would be able to place a boat at the disposal of the Association, so that, most reluctantly, since the Royal Mail Co. had treated the Association with the utmost courtesy and consideration throughout, the Eclipse Committee had to bring the negotiations to a close. They then had to look around for another boat, which was by no means an easy matter, and they succeeded in obtaining an offer of a smaller boat; but as a large number of those who had engaged berths on the "Tagus" declined to make the desired transfer to the smaller boat, the idea of a steamer excursion had to be abandoned. He did not think, however, that this should prevent those who had made up their minds to observe the eclipse from doing so. There were several routes open, though they could no longer go as one large organised party. He had mentioned one or two possible routes in the "Journal," and since that went to press he had received some further information from the Royal Mail Co. That Company wrote, that if several observers wished to land at Oporto, they would arrange that the boat leaving Southampton on May 11 should call at that port, otherwise it would call only at Lisbon. A return steamer would leave Lisbon on May 30. Through their agents at Lisbon the Company sent the following particulars:—The train leaving Oporto at 11 a.m. arrived at Valenca at 3.10 p.m., and connected with a train arriving at Vigo about 7 p.m. The trains from Lisbon to Ovar, which was on the central line, took 12 to 13 hours to cover the journey. The hotel, or rather inn, at Ovar was but a small one, with poor accommodation; it adjoined the station. It was suggested by the Royal Mail Co.'s agents that visitors should make Oporto their headquarters, where better accommodation was to be obtained. Ovar was only $1^h\ 40^m$ by rail from Oporto by the 8.15 a.m. train, and there were several trains back to Oporto in the afternoon. It might be possible to rent a house at Ovar for the time, if required, and he might add that the Portuguese railways had promised to issue tickets at half fares for foreign astronomers visiting the country in order to view the eclipse. There would thus be no difficulty in getting to Ovar, the Portuguese eclipse station. For the interior of Spain, Messrs. T. Cook and Sons were arranging a tour to Navalmoral, near Talavera. There was another way in which they might proceed, viz., by Gibraltar by P. and O.

steamer, and then by rail to Alcazar de San Juan, a railway junction about 15 miles from the central line, where totality would be of about one minute's duration. There was, moreover, a line of steamers from Liverpool to Alicante. There was an overland tour being arranged by Messrs. Cook and Sons to Algiers, and there were two lines of steamers running from Liverpool to Algiers. The French Astronomical Society had arranged a tour from Marseilles to Alicante, particulars of which were given in a recently published Bulletin. There would thus be no difficulty in getting to several stations in either Portugal, Spain, or Algiers, and he trusted that those Members who intended to go to see the eclipse would communicate with him, so that the Committee might have an idea as to what instruments were going to be used, and what work was going to be taken up, in order that under the somewhat unfortunate circumstances, they might organise their observations as thoroughly as it was possible.

Mr. Crommelin gave particulars of an expedition being arranged by the French Astronomical Society, remarking that he had no doubt they would welcome any Members of this Association on the same terms. The price of the journey from Marseilles and back to the same place, was fixed at 460 fr., or a little over 18*l.* Leaving Marseilles on May 22, the Tuesday before the eclipse, the next day would be spent at Barcelona, and, touching at Tarragona and Valencia, Alicante would be reached early on Saturday, the 26th. A stay would be made there till Monday, the Members of the Expedition either remaining on board ship, or travelling to Elche, on the central line, without any further charge. Alicante would be left on the evening of the 28th, immediately after the eclipse, and the ticket included a journey to, and into the interior of both Majorca and Minorca, the return journey to Marseilles being made on May 31. People would, of course, have to find their way to Marseilles; but it was hoped to make arrangements with the French railway companies to issue return tickets at single fares from any French station to Marseilles. All instruments would be conveyed by steamer without extra charge.

The *President* said it was a source of great regret to the Association that their own Expedition, from which they had hoped for so much, had had to be abandoned; but, although they had not been able to organise it successfully, he thought they owed as great a debt to Mr. Maunder as if they had done so. Very few people knew how much work Mr. Maunder and his brother, Mr. T. F. Maunder, had done in connexion with the matter. The amount of correspondence had been very large, and the number of interviews necessitated must have involved a very great demand upon Mr. Maunder's time. The President formally tendered the thanks of the Association to Mr. Maunder. He then went on to say that Mr. Chambers had an announcement to make regarding the manner in which Members might occupy the time between the 11th of May and the date of the Eclipse, if any of them adopted the suggestion of Mr. Maunder as to going to Lisbon by the steamer which would leave on May 11.

Mr. G. F. Chambers desired to emphasise what he might call the claims of North Portugal in the matter of observations of the eclipse. For some time past he had been in communication with the Royal Mail Company on the question of landing a party of Members of the Association at Oporto, and he had received an intimation that if within an early period a sufficient number of names were forthcoming of those willing to land at Oporto, they would put a party ashore about Monday, May 14, and he understood the company might easily be induced to pick up the same passengers at Oporto about June 1 on the homeward voyage, so as to avoid Lisbon. He had consulted friends connected with Portugal, and there was rather a concurrence of opinion that Lisbon was not a place worth going to, for there was not much to see there; but at Oporto there was a very good opportunity of most pleasantly and profitably employing the time between, say, the 15th and 28th of May. To begin with, Oporto was quite as good a place to land at as Lisbon for passengers going to Central Spain. Further, Oporto was an exceedingly interesting city, with a great deal to see in and around it, especially the country to the south of it, where the battle of Busaco was fought, and some 30 or 40 miles still further south, where there were two of the most beautiful specimens of Gothic architecture which was reputed to exist in Europe—Batalha and Alcobaça. Another point in favour of Oporto was that although Ovar was very close to the Atlantic coast, the fogs on the coast of Portugal were not to be feared during the month of May. The fog season which prevailed on the Atlantic seaboard of Portugal was rather the months of August and September. Ovar was certainly a place not to be slept at; it was, however, only 22 miles from Oporto, and there was railway and steam tramway communication between the two places. Moreover, Oporto could be reached most cheaply of all the stations which had been under consideration. Mr. Crommelin had told them that the fare to Spain from and back to Marseilles was 18*l.*, but they would first have to get to Marseilles, and that journey would cost about 15*l.* from London, first class; whereas the fare by the Royal Mail Company's boats from Southampton to Oporto and back was only about 10*l.* 17*s.* 6*d.*, and passengers by that route could see the eclipse, and the whole of the country around, spending three weeks in all, for a sum not exceeding 20*l.*

A paper by the *Rev. S. J. Johnson* was read on Suggestions for the Observation of the Partial Phase of the coming Eclipse. (*See* p. 257.)

Mr. Maunder said there was one observation which he trusted would be attempted in England during the partial eclipse here—namely, photographing the corona at the time of the greatest obscuration. He thought it would be advisable to cover the entire disk of the sun with a diaphragm placed as near as might be in the primary focus. For this it would be advisable to have a photographic camera of considerable focal length. In order that that might be done effectively, it would be of advantage not only to have a photographic telescope, but also a good guiding telescope rigidly attached to it. This was a matter that those

staying in England during the eclipse might well take up, especially those who had a good photographic equipment. They might not succeed this time, but they lived in hopes of at some time being able to photograph the corona while there was still a large amount of sunlight visible as well as during the total phase.

Col. Burton-Brown alluded to the difficulties to which, to his own knowledge, were experienced at the hands of the Customs authorities by astronomers visiting Spain some 30 years ago, and strongly urged that, prior to the coming eclipse, officials of the Association should communicate with the British Consuls at the different stations in Spain and Portugal, asking them to obtain authority for any of their observers to pass their instruments through without difficulty. Mr. Maunder's suggestion that a house might be obtained at Ovar was a good one, for the Members observing there would thus get over the dilatoriness and delays which characterised the means of communication in Spain and Portugal. In any case, he would recommend that observers be at their stations several days before the date of the eclipse, so as to make certain of being there in time. There were few places better than Ovar for the ordinary observer; the chances there seemed exceedingly good. Many people considered Navalmoral would be a good place, too; but they might experience difficulties with the Custom House authorities, as well as regarding the transport of instruments. Alicante and Algiers were also very good, and it should be remembered that people who went direct to any seaport would only have to deal with one Custom House.

Mr. Goodacre thought that if the dark body of the moon were at all visible in England it would be well for observers here to see if the limb were at all brighter than the central portion, which might, perhaps, be some evidence of a lunar atmosphere.

Mr. Crommelin read some notes upon "The Zodiacal Lights and Gegenschein," being extracts from a paper, by Mr. F. J. Bayldon (communicated to the New South Wales Branch of the Association), which had been made by Mr. W. F. Gale. (*See* p. 260.)

A report from *Capt. Molesworth*, Director of the Zodiacal Light Section, was read. (*See* p. 253.)

Mr. Maunder was very glad to find the Zodiacal Light Section was setting to work in real earnest. The observations by Mr. Bayldon seemed to promise very good work from that Section in the future. What Mr. Bayldon said about the lunar Zodiacal Light was especially interesting. Of course, he was not the first observer who had remarked it, but they had had hitherto so very few observers of a lunar Zodiacal Light that the observations had been considered as more or less open to criticism, and it had been considered a mere atmospheric, or possibly an optical, effect. If, however, Mr. Bayldon could give them some more details of his observations, it was possible the idea of a real lunar Zodiacal Light might be resuscitated. He (the speaker) was very pleased to hear of Mr. Bayldon's observation of the difference between the colour and appearance of the Milky Way in the Zodiacal Light. Mr. Bayldon spoke of the Milky Way as being steely blue, and the

Zodiacal Light of a milky character. A slight yellowish or some what creamy tint was just the impression which it produced upon himself (the speaker) when he saw the Zodiacal Light on his way out to India in 1898, and the contrast between that and the steely blue, as Mr. Bayldon aptly called it, of the Galaxy was distinctly noticeable.

Mr. Goodacre read a paper on "The Duplication of the Canals of Mars." (*See* p. 254.)

Mr. Maunder said he made a few experiments some years ago on the limit of sight, without optical aid, for small objects, and found that whereas the smallest dot that one could clearly see with the eye must subtend an angle of about 40 secs., he was perfectly conscious of the existence of a line when it only had a breadth of about 8 secs. At the same time it could not be called distinct vision—he was conscious of the line, but it was not sharply defined on the eye. The reason, he supposed, was that the dot simply affected one element of the retina, 40 secs. being about the diameter of the rods of the retina, whilst the line passed over a number of them, and so produced a certain indistinct but appreciable effect. It seemed to him, therefore, that if they had on a planet or any celestial object a number of small markings, each of them individually below the limit of distinct vision, they might very easily get the effect of narrow straight lines, and from the beginning of the controversy as to the canals of Mars it had seemed to him that a good many of them probably owed their existence to something of the sort. The observers were really trying to form a distinct impression from the confused result of an aggregate of minute markings, each of which was individually beyond the power of the eye to grasp. The paper read by Mr. Goodacre suggested to him that the same cause might also account for the appearance of doubling.

The *President* thought it was a common experience that telegraph wires were distinct, as separate wires, a very great distance.

Mr. Adams said that, unless the atmosphere was very dense, telegraph wires were distinct a very considerable distance away, but any change of atmosphere affected their visibility at once.

Mr. Maunder said he tried a wire, but 7 secs. of arc was the smallest diameter he was able certainly to recognise.

Mr. Chambers read some extracts from a report of the Coloured Star Section under the title of "A Catalogue of Red Stars for 1900."

A paper by Mr. Gavin J. Burns, on "The Proper Motion of Stars," was read. (*See* p. 259.)

Mr. Maunder read portions of a report of the Meteoric Section, compiled by Mr. W. F. Denning, the Director.

The Meeting adjourned at 7 p.m.

Reports of the Branches.

NORTH-WESTERN BRANCH (MANCHESTER).

The Sixth Meeting of the Session was held on March 7, when the Chair was occupied by the President, Prof. T. H. Core, M.A. The preliminary business having been disposed of, Mr. Herbert Bury, M.A., was elected a Member of the Association, and signed the roll. A lecture was afterwards delivered by the Rev. A. L. Cortie, S.J., F.R.A.S., on "The Work and Problems for the forthcoming Solar Eclipse."

The lecturer first explained the laws of the recurrence of eclipses, and especially called attention to that first pointed out by Mr. Crommelin, that 47 lunations, being almost exactly one-fifth of 19 years, the eclipses at any node have a periodic return after this length of time, and after 19 years recur on almost exactly the same day. The coming eclipse is one of a descending node series which first appeared as a partial eclipse on August 9, 1877, and will, too, after five periods of 19 years leave the earth as a partial eclipse on the same date in 1953. The Norwegian eclipse of August 9, 1896, belonged to the same series as the coming eclipse, which also is a fellow to the eclipse of May 27 1881.

Beginning with the year 1842, when scientific observation of total solar eclipses may be said to have had its rise, the lecturer, explained how the prominences had been shown first to be certainly not lunar appendages, and finally, by the aid of photography, not mere effects of ocular delusion, but true solar phenomena. The year 1868 introduced the spectroscope as an adjunct to the optical outfit of an eclipse observer, and it was at once proved that the red flames were mainly composed of hydrogen gas. Hence was inaugurated a systematic observation of the solar prominences in full daylight by the spectroscopic method. The further knowledge gained in successive eclipses that the violet calcium rays were strongly marked in the prominence spectra led to the photographing of the prominences, and the incandescent vapours on and off the sun, by means of monochromatic light by the use of the spectroheliograph. The results of observations made in this manner, and of prominences observed on the red line of hydrogen by the open slit method, were projected on the screen. Schaeberle's magnificent photograph of the inner corona and the prominences, taken in 1893, was discussed, and particular attention was called to the necessity in coming eclipses of studying in detail the connexion between the prominences and the rays of the inner corona, for some connexion seems to exist; as also the white prominences first seen by Tacchini. It was suggested that eye observations by means of telescopes of from 3 to 5 inches aperture could be usefully made with regard to this point. But the necessity of confining the attention to one particular prominence and its surrounding rays, and of studying that, without being anxious to do too much, was strongly urged on observers. It was suggested, that if feasible, a tracing on ground glass of the direct image of the coronal rays

would be more valuable than a drawing made from the impressions derived at the end of the telescope.

The various instruments used in eclipse observations were next explained and illustrated, including the disk for enabling the extensions of the corona to be drawn, the cœlostat, and the prismatic camera.

Another series of slides exhibited the various types of corona corresponding to maximum, minimum, and intermediate sun-spot activity. The 11-year period was excellently illustrated by the pictures and photographs shown, and, incidentally, the value of good drawings was touched upon.

The lecture concluded with a discussion of the chief results of the total solar eclipse of 1898, January 22, of which a beautiful series of slides was shown, including photographs taken by the Astronomer Royal, Capt. Hills, Mr. Evershed's wonderful series of chromosphere and flash spectra, and a series of excellent photographs taken by a party of Jesuit Fathers at Dumraon with very modest equipment. Mrs. Maunder's two very valuable photographs were also exhibited. In camera work by amateurs, the lecturer insisted on stability and rigidity in the instrument. He advised that the lens should be mounted in a wooden box, which, again, if not used on an equatorial mounting should be nailed to a post driven into the ground. He also called attention to the necessity of constant practice of even the simple operations which amateur observations would entail, so that there should be no hurry, no flurry, and that nothing should be forgotten during the precious moments of total eclipse. It would be a great aid, also, to read up the subject in one's leisure hours. The discourse was illustrated by some 60 slides in all.

The Seventh Meeting of the Session was held on the evening of April 4th; the President (Prof. T. H. Core, M.A.) occupying the chair.

In the course of the interval given to general scientific conversation, the Secretary announced the results of his inquiries as to the several routes which may be taken to view the approaching Solar Eclipse, as well as the probable cost. It appeared that about half-a-dozen members hoped to go out, but there was, so far, no concerted plan. Their intention was, however, to take observations at several places along the line of totality, at Viseu, Plasencia, Alicante, and Algiers, and the results were looked forward to with interest.

Mr. Buss then read a paper on Diffraction Gratings and Spectroscopes; giving first an historic account of the subject, he proceeded to deal with his own experiences in the use of the instrument attached to his telescope of 3-inch aperture. Numerous interesting details were given, and amateurs were encouraged to take up the study and practice of the subject. The paper was illustrated by means of slides, some of which had been specially prepared, and others were from the lantern slide department of the Association. The members testified their appreciation of the lecture, and at its close a hearty vote of thanks was awarded to Mr. Buss.

WEST OF SCOTLAND BRANCH (GLASGOW).

The sixth monthly meeting of the session was held in the Association's Room, in the Athenæum, on Friday evening, March 16th, Mr. John Dansken, F.R.A.S., Vice-president, in the chair. Major Cassells gave some interesting illustrations of the stellar depths, after which Mr. David Hunter, F.R.A.S., read "Notes on Observational Astronomy," giving the results of his 15 years experience with telescopes varying from 3¼-ins. to 13-in. aperture. He expressed a preference for reflecting rather than refracting telescopes, and concluded by exhibiting some good specimens of his recent work in lunar photography. Mr. Robert Robertson, B.Sc., then read a paper on "The Tides." After dealing with the various theories of the causes of the tides, and explaining more fully those of Newton and Laplace, known as the equilibrium and kinetic theory respectively, he explained, by means of a series of diagrams, the individual effects of the sun and moon as the tide producing bodies. The effect of the difference in the periods of the solar and lunar tides in producing the spring and neap tides, and also in causing the variation in the interval between successive high waters, known as "the priming" and "lagging" of the tides, was then fully explained. The influence upon the tides of the changes in declination of the sun and moon, and the variations in their distance from the earth, was next dealt with, and their effect in producing extreme tidal variations during winter and at the equinoxes was explained. Charts of the world and the British seas were then put upon the screen to illustrate the progress of the great initial tidal wave. This wave was traced out upon the charts, commencing in the Pacific Ocean off the West Coast of South America, passing westwards round Australia, through the Indian Ocean, and turning northwards into the Atlantic Ocean. The course of the main portion of the wave after reaching the British coast was further traced up the west coast of Ireland and north of Scotland, passing thence into the North Sea, and finally causing high water in the Thames at London some 60 hours after the initial wave was generated off the west coast of South America. Numerous examples of anomalies in the range of tides at different parts of the earth were given, and their causes explained. After dealing shortly with the subject of the prediction of tides, and explaining the instruments designed by Lord Kelvin for this purpose, the paper was brought to a close with a short reference to the doctrine propounded by Prof. G. H. Darwin as to the effect of tidal friction upon the relative motions of the earth and moon. Although this doctrine shows that the effect of tidal friction is, at the present time, increasing the length of the day, and will continue to do so until the day and month ultimately become equal, it was pointed out that the rate of increase is estimated not to exceed a fraction of a second in a thousand years, and that therefore the final stage would not be reached till long after the earth was—from other causes—no longer a suitable place of abode for human beings. The lecture was frequently applauded, and, on the motion of the chairman, a vote of thanks was cordially awarded to Mr. Robertson.

At the close of the Meeting a Special General Meeting was held, when, by a majority, rules 8 and 9 were rescinded and the Council's amendments agreed to.

The Seventh Meeting of this Session was held in the Athenæum on Friday evening, and took the form of a conversazione and astronomical exhibition; the President, Rev. Edward Bruce Kirk, in the chair. There was a crowded attendance. During the evening the President gave a short sketch of cometary physics, and the Vice-President, ex-Bailie Dansken, F.R.A.S., gave a brief outline of Nasmyth's life and work, in which he dwelt especially on the fact that while Nasmyth was one of the most enterprising and successful of business men—being the inventor of the steam hammer—he yet found time for astronomical research, and latterly he retired and became famous as the most world-renowned delineator of the moon's surface. The addresses were illustrated with beautiful limelight views by Major Cassells. The exhibits—numbering over 120—were neatly catalogued and described in book form by Mr. Dansken, who presented those present with a copy—included astronomical instruments, engravings, photographs, and illustrated works kindly lent by the Royal Astronomical Society, British Astronomical Association, Messrs. D. M'Gregor & Co., and others. Among the exhibits were an original copy of Copernicus's famous work, "De Revolutionibus Orbium Celestium," Sir Isaac Newton's "Principia Philosophiæ," Father Secchi's "Le Soleil," Cottam's "Charts of the Constellations," also "Photo Atlas of the Moon," 20 sheets, 1895–96, Lick Observatory, "Atlas Photographique de la Lune," 1897–98, Paris Observatory, and Dr. Isaac Roberts's recent volumes "Photographs of Star Clusters and Nebulæ." Rev. John Smith, B.D., Chairman Govan School Board, in moving a vote of thanks to the Council, said he was very pleased to see such a large and representative audience taking an interest in the subject of astronomy. The artist, he said, sees beauty in the landscape, the mathematician in the solving of some knotty problem, and, none the less, the astronomer even in his considerations of the parallax of the most distant stars. Dr. Henry Dyer, in supporting the motion, said he was glad to see some teachers present. Recent developments had made the subject of "nature knowledge" an essential part of the school curriculum. The difficulty the Glasgow School Board now had was to find teachers qualified to impart this knowledge. Here, in this voluntary association was an opportunity of receiving some such knowledge, and he would be pleased to learn that many teachers would take advantage of it. The scientific habit of thought and the problems brought within range of even the average amateur in astronomy, could not but have a great effect on the philosophy of after life. The usual votes of thanks concluded a very successful meeting.

EAST OF SCOTLAND (EDINBURGH).

The last Meeting of this Branch for the current Session was held at No. 5, St. Andrew Square, Edinburgh, on the evening of Saturday, 21st April, the President in the chair.

A paper on "A Graphic Method of predicting Occultations" was read by Mr. Thomas Heath, B.A., of the Royal Observatory, Edinburgh. The paper explained a method of predicting occultations for stations other than Greenwich, devised by the late Rev. Prof. Chevallier, of Durham College, which considerably reduced the amount of work involved in such a calculation. The method consisted in taking the occultation time for Greenwich and applying the necessary correction, by graphic means, for other stations. Tables had been prepared for six stations in the British Isles, and a set of these for Edinburgh was shown. Two examples of predictions of occultations at Edinburgh were shown by Mr. Heath, who pointed out that with the help of the "Nautical Almanac" and the special tables shown, very little work was required to bring out the time, within practical limits, for a prediction.

Mr. Charles F. Smith also gave a paper, illustrated by lantern views, upon "The work of Amateurs." He dealt, in the first place, with the question of suitable instruments for different kinds of work, showing slides of various amateurs' instruments and observatories, and then pointed out in what directions the efforts of amateurs could probably best be directed. Various methods of planetary and lunar observation and delineation were explained and discussed, and astronomical photography by amateurs was briefly dealt with. The illustrations consisted of a number of specially prepared slides, supplemented by a number from the Association's own collection.

Votes of thanks were accorded to both speakers, and some discussion followed.

VICTORIA BRANCH (MELBOURNE).

The First Ordinary General Meeting of the current Session was held on 1st March 1900. Prof. Kernot, M.A., C.E., F.R.G.S., in the chair.

Election of Office Bearers.

It was thought advisable by the acting council to nominate new men to the several offices of the Association, so that a larger number of Members might have an opportunity of serving in the interests of the Branch. The following was the result of the election:—

President.—Rev. John Meiklejohn, M.A.

Vice-Presidents { Robert Gillespie.
Dr. Sprigg, LL.D.

Members of Committee.

Rev. E. H. Chapple, Messrs. R. Schäfer, J. W. Horwood, R. W. Wigmore, and Mrs. R. S. Whiting.

Hon. Treasurer.—John Laver, 336, Flinders Street.

Hon. Secretary.—David Ross, National Bank, Melbourne.

A vote of thanks having been accorded to the retiring office-bearers, the Chairman vacated the chair in favour of the new

President (Mr. Meiklejohn), who thanked the Members for his election, and expressed the hope that the valuable assistance rendered to the Association by Mr. Baracchi and others amongst the retiring office-bearers would be continued.

Two new names were nominated for election.

A paper by Capt. W. C. Thomson was communicated by Mr. A. C. Macdonald on "A simple method of determining Latitude." Several Members took part in the discussion which followed.

Mr. Macdonald was asked to thank Capt. Thomson for his paper. The Meeting closed at 9.45.

Reports of the Directors of the Observing Sections.

Variable Star Section.

Interim Report.

The Director has furnished the Members with a working list of stars for observation, giving the principal particulars of each star as given in Chandler's 3rd Catalogue of Variable Stars. Also with maps of the vicinity of each variable, and a list of magnitudes of the comparison stars. It is hoped to adopt a better method of reproduction of the maps in future, viz., by hectograph. The ascertaining the magnitudes of the comparison stars was troublesome, and authoritative data in this matter will be regarded as an immense boon when it is published, either by Professor Pickering or Father Hagen. The latter's Atlas of Variable Stars will surely prove a *vade mecum* to all observers in this department of astronomy, and it is hoped that the Council will assist by authorising the purchase of at least a portion of this work.

The following have joined, and may be regarded as working Members of the Section, the abbreviations by which their observations will be distinguished being added.

	Abbreviations.
Miss M. A. Orr	Or.
W. E. Besley	B.
W. A. Edwards	E.
Brigade-Surgeon J. Kelly	Ke.
Rev. R. Killip	Kp.
A. King	Kn.
G. W. Middleton	Mi.
W. Oakes	Oa.
Rev. W. R. Waugh	Wa.
J. T. Wood	Wo.
W. M. Worssell	Wl.
The Director	Ma.

Prof. E. C. Pickering, the Rev. T. E. Espin, and Herr Plassmann, have all written to the Director expressing their interest in the Section, and the two first-named have cordially furnished valuable assistance.

Members have sent in all their observations of the 12 stars detailed on p. 113, Vol. X. of the "Journal," up to 31st March 1900, so that the period embraced is only a little over two months, the opening circular being sent out about the middle of January.

Two hundred and five determinations of magnitudes have been made altogether, all differential. As each determination of magnitude involves generally comparison with two stars, the actual number of separate comparisons made will be probably double this number. The observations are thus distributed:—

——	Kn.	Oa.	Or.	Ma.	Mi.	Wl.	Total.
U Cephei	—	—	—	13	7	—	20
U Orionis	—	—	4	8	7	11	30
R Leonis	2	—	10	17	4	5	38
R Ursæ Maj.	—	—	—	1	—	—	1
S Ursæ Maj.	—	—	2	9	1	3	15
β Persei	—	—	23	8	3	6	40
α Orionis	—	2	5	7	3	6	23
T Monocerotis	—	—	11	7	15	1	34
R Coronæ Bor.	—	—	1	1	—	—	2
β Lyræ	—	—	—	—	2	—	2
Total	2	2	56	71	42	32	205

The above do not include cases where a star was looked for, but not found, or was too faint to be visible in the instrument used.

Great advantage has accrued from the observers all adopting a uniform method of recording their observations, which is based on the practice of the late Mr. Knott.

In addition to the above, Mr. Besley has sent in a number of observations of variables and suspected variables made in the years 1898 and 1899, which will be dealt with later.

I hope, by sending out occasional circulars, to keep up the interest of Members; it is such an incentive in this kind of work to know what others are doing. Many of the observations, nay, I may say, most of those already sent in are excellent in quality, and I feel sure that now the climatic conditions are becoming less rigorous, a largely increased harvest of observations will result. I do not think I am betraying confidence when I state that the regular duties of one of our members occupy him daily from 6 a.m. to 9 p.m., Sundays excepted, and that he lives by himself. At the end of the day, therefore, he is greatly in need of repose. Notwithstanding such adverse conditions, he has sent in an excellent series of observations, some made in the early morning. These do him the greatest honour as one of nature's astronomers. Think of it, ye luxurious ones, who possess leisure and the means of observing in comfort.

When the time comes the observations of each star will be published in the "Report" in full detail, for I am certain that it is but little use publishing the "deduced magnitudes" only. The work to be of use to other investigators in the same field, must give the detailed comparisons, so that the results may be reduced to any scale desirable. It would occupy too much space to do this here, but I append a specimen table showing the form in which the observations will eventually be recorded.

(3493) *R Leonis.*

Date and Hour of Observation G.M.T.	Sky.	Inst.	Light Estimates.	Remarks.	Deduced Magnitude.	Observer.
1900. h m						
Jan. 24 ·	1	Bin.	Decidedly < 19 Leonis.	—	7±	Or.
Feb. 4 ·	3	Bin.	< 19 . .	—	6·75±	Or.
" 6 · 9 0	2 M	T 28	5 < 19 . . .	Well seen. Ruddy.	6·93	Ma.
" 6 · 9 0	3	Bin.	Little < 19 .	—	6·6 ±	Or.
" 7 · 9 11	1 M	Bin.	3 < 19 . .	—	6·73	Ma.
" 7 · 10 54	1 M	T 38	1 < 19, 3 > ψ .	—	6·53	Wl.
" 16 · 9 30	2	Bin.	Little > 19, much < 18.	Strong moonlight.	6·2	Or.
" 17 · 10 59	2 M	T 38 and 76	2 > 19, 4 < 18 .	—	6·23	Wl.
" 20 · 7 10	2	Bin.	Little > 19, < 18, nearer 19.	Drifting clouds	6·2	Or.
" · 9 0	2	Bin.	2 < 19, about = C	—	6·94	Ma.
" · 9 30	1	Bin. and T 30	> 19 . .	—	>6·43	Mi.
" 22 · 8 50	1	Bin.	Little > 19, decidedly > 19.	—	6·2	Or.
" 25 · 9 30	2	Bin.	1 < 19 . .	Clouds about .	6·53	Ma.
Mar. 1 · 8 35	2	Bin.	Little but decidedly > 19, distinctly < 18.	Clear between clouds.	6·2	Or.
" · 10 27	1	Bin.	1 > 19 . .	Good view .	6·33	Ma.
" 4 · 10 2	1	Bin.	1 > 19 . .	Good . . .	6·33	Ma.
" 5 · 9 52	2 M	Bin. / T 28	1 > 19 . . / 4 > 19, ½ way from 19 to 18.	A beautiful picture. Ruddy.	6·12	Ma.
" 9 · 9 59	2 M	Bin.	Just = 18 . .	—	5·84	Ma.
" 11 · 10 5	2 M	Bin.	2 < 18 . .	Difficult . .	6·04	Ma.
" 12 · 10 29	1 M	Bin.	1 < 18, much > 19	Bright moon near.	5·94	Ma.
" 15 · 9 45	1 M	Bin.	Just = 18 . .	Do. .	5·84	Ma.
" 16 · 8 43	M	Bin. and T 28	About = 18 .	—	5·84	Ma.
" 17 · 8 18	1	Bin.	Much > 19, = 18	—	5·8	Or.
" · 8 40	2 M	Bin.	0·5 step > 18 .	A pretty good view.	5·79	Ma.
" 19 ·	3	—	6·0 . . .	Much haze .	6·0	Kn.
" 19 · 9 43	1	Bin.	A little (? 2 steps) > 18.	Orange red .	5·6	Or.
" 20	—	—	7 > 19, 2 > 18, 8 > κ.	—	5·73	Kn.

Date and Hour of Observation G.M.T.	Sky.	Inst.	Light Estimates.	Remarks.	Deduced Magnitude.	Observers.
1900. h m						
Mar. 20 · 9 0	1	Bin.	4 > 18 · ·	Good · ·	5·44	M
„ · 9 15	1	Fin. 8	3 > 19, 1 < 18 ·	Unsatisfactory ·	6·03	Wl.
„ · 9 30	1	Bin.	1 > 18, < ν · ·	Red · ·	5·7	Or.
„ 24 · 9 54	1	Fin. 8	= 18 · · ·	Unsatisfactory ·	5·84	W
„ 26 · 9 10	1	Bin.	2 > 18 · ·	Ruddy. Fine sky.	5·64	Ma.
„ · 11 20	1	Bin.	4 > 18, 2 > ψ ·	Superb sky ·	5·45	Ma.
„ 28 · 9 15	1	Bin.	5 > 18 · ·	Good · ·	5·34	Mi.
„ 29 · 9 18	1	Fin. 8	4 > 19, 2 < 18 ·	Unsatisfactory ·	6·03	Wl.
„ 30 · 8 30	2	Bin.	5 > 18, 2 > ψ, Perhaps = ν.	Much haze about	5·37	Ma.
„ 31 · 9 39	2	Bin.	6 > 18, 5 > ψ, 3 < ν.	Poor sky ·	5·40	Ma.
„ · 9 50	1	Bin.	6 > 18 ? ·	Probably over-estimated.	5·24	Mi.

In the preceding table, the light estimates are made in steps, or tenths of a magnitude as nearly as possible, and the magnitudes of the comparison stars are almost wholly taken from Prof. Pickering, having been communicated to Members. A glance at this table shows the value of co-operation, a very complete series of determinations of brightness having been secured, compared to which each contributor's work, alone, makes but a poor show. The star was evidently still brightening at the end of March, and if observations are continued, the maximum ought to be allocated within a few days.

Another point which Members can see easily from the table is the desirability of adhering closely to the form of record already circulated. In the matter of the hour of observation, it is true that in the discussion of a long period visible, it is not strictly necessary to be recorded, the variation being practically nil in a period anything under 24 hours; but when we come to assemble different observers' work, it is really necessary to have hour and minute of observation recorded so as to place the different observations in their correct chronological order.

The discussion of the date of maximum and shape of light curve of R Leonis and other stars will have to be reserved for the report.

The following are brief notes as to the other stars in the list:—

U Cephei.—Only three observers have tackled this star, and nothing very definite has resulted, owing principally to the binocular being used. Mi. noted it as invisible on January 27 at 10^h 40^m, and again on February 1 at 9^h 30^m; while Or. could not see it on February 11 at 6^h 35^m. On these three dates the

star may have been faint. This star wants to be followed in the telescope if definite light determinations are to be made. It is too faint in the binocular.

U Orionis.—On January 29, Ma. made it 11·25; after this it soon began to increase, and on March 31 it was 6·37. If the star can be observed in the western sky it may be possible to get the maximum fairly accurately, although it lingers long at time of greatest brightness.

R Ursæ Majoris,—No observations received. Up to March 16 it was invisible to Ma. in 2¾-in. refractor; but on March 30 it was about 10½, and is evidently now on the rise. This is a very easy star to find in the telescope or binocular owing to its configuration with H.P., 1876 and 1878.

S Ursæ Majoris.—Authorities seem to differ in predicting date of maximum. In our series it was observed brightest on February 20, at $7·16^m$ by Ma., after which it was evidently on the decline.

β Persei (Algol).—Mi. observed it $<3·18$, January 27, $6^h\ 5^m$. Or. has an interesting series of 12 separate determinations, on February 16 between $6^h\ 10^m$ and $8^h\ 52^m$. Decrease, $2·7^m$ to $3·3^m$. These and other observations require plotting on a diagram according to "phase," in order that it may be seen whether they support or not the theoretical light-curve.

α Orionis.—The generality of observers make it 0·7 or $0·8^m$. On January 24, Or. made it 0·2, and on February 16, 0·4. These estimates are probably higher than the truth.

T Monocerotis.—A capital series has been secured ranging from 6·9 to 7·6. These must be plotted on the light curve according to phase, when no doubt interesting results will transpire; but this requires a diagram, and I do not propose to prepare any diagram until the report is compiled.

R Coronæ Borealis and *β Lyræ.*—Only two observations of each of these stars received, doubtless owing to their not yet being in season.

On the whole I think we may congratulate ourselves on what has been done in the past two months, and I feel it is only an earnest of what is to come. Observations of the long period variables mentioned, when in fainter stages, should be made by the telescope. There is a tendency to resort often only to the binocular (and to no one does this apply more than the Director) on account of the facility with which observations by that charming instrument can be made; but it must be remembered that a telescope is absolutely necessary when a star gets anything below 7^m.

A further list of stars for observation will be notified to the Section shortly, as some of those referred to above are now verging westward; but it is strongly advised to follow the circumpolar variables named all through the year as far as possible.

Devonport,
15 April, 1900.

E. E. MARKWICK, Col.,
Director of the Section.

Zodiacal Light Section.

Interim Report.

Several Members have already joined the Section, and sent in some valuable notes, but I must again appeal to the Members of the Association for more recruits.

If good results are to be obtained, the Section should be as numerous as possible, and include observers in different latitudes.

There is no need of instruments. The only requisites for good observations are patience and a knowledge of the stars, which can be easily attained.

I would specially appeal to travellers and sailors, who have exceptional opportunities, and who may sometimes find time pass rather slowly on board ship. Mr. Bayldon's valuable paper shows what can be done in this way.

I hope that those who form the Eclipse Expedition this year will find time for a few observations both at sea and ashore.

There are one or two points I should like to call attention to in addition to those mentioned in my previous notice (British Astronomical Association Journal, Vol. IX., No. 6, p. 285) :—

1. *Pulsations in the Light.*—Cassini (1683), Humboldt, Birt, and Lowe (1850), observers at Kew (1854), and Jones (1854), all speak of definite pulsations and variations in the Zodiacal Light at short intervals.

These may be illusions caused by the strain of long-continued gazing at a faint object, or by alterations in the brightness of the sky. At the same time the evidence in their favour is too strong to be contemptuously passed over.

The greatest care must, however, be exercised to guard against all possible causes of illusion. If the Galaxy is available, the Zodiacal Light and Galaxy should be compared, and areas of equal brightness selected in each. Should variation in the Zodiacal Light be suspected, these areas should be frequently compared to eliminate the effects of twilight.

2. *Shifting of the Axis in Latitude.*—If possible the boundaries of the Zodiacal Light should be determined more than once on the same date, and any apparent displacement of the axis in latitude should be recorded.

3. *Influence of the Moon and Brighter Planets.*—The influence of the moon on the Zodiacal Light is another point to be decided. Observations made as to how long before and after new moon the Zodiacal Light remains visible would give a fair gauge of the intensity of the light.

Jones gives several instances of the rising moon being preceded by a zodiacal cone, smaller than, but very much resembling, the morning Zodiacal Light, and quite distinct from atmospheric moonlight. Mr. Bayldon's observations also indicate something peculiar. Any appearance of this sort should be carefully noted.

4. It will simplify the compilation of the reports greatly if those sending in observations would enter the following particulars:—

(i.) Co-ordinates of the visible apex of the cone.
(ii.) Co-ordinates of the farthest point to which the band is traceable.
(iii.) Angle formed at apex by the boundaries of the cone.
(iv.) Breadth of band at various points.
(v.) Whether the N. and S. boundaries of the cone are equally distinct.
(vi.) Co-ordinates of apparent centre of "Gegenschein" (if observed), and extent of major and minor axis.

These should only be fixed during the observation with reference to neighbouring stars, as it is most important that no reference to charts, on which the equator and ecliptic are shown, should be made, until the observation is completed. At the end of the observation the figures may be inserted.

The co-ordinates may be referred either to the equator (R.A. and Dec.), or to the ecliptic (longitude and latitude).

P. B. MOLESWORTH,
Captain, R.E.,
Director of the Section.

Trincomalee, Ceylon,
15th February 1900.

Papers communicated to the Association.

On the Duplication of the Canals of Mars.

By WALTER GOODACRE, F.R.A.S.

I have followed with interest the discussion which has taken place on this important subject. I have not, however, given any continuous attention to the telescopic appearance of Mars, so that the mere fact that I have never been able to see anything approaching duplications in any of the Martian details (although using a reflecting telescope of 12-in. aperture) probably does not entitle me to express any dogmatic opinion on one side or the other. I should therefore not have ventured to put forward any hypothesis of my own had I not recently become aware that my views were also held by some others more competent to deal with the problem.

I was at first attracted to the idea that these duplications were the outcome of a slight inaccuracy in the focussing of the telescope; more especially as on one occasion I had succeeded in doubling the well-known coarse cleft on the floor of the Lunar Crater Petavius, in consequence of this very reason, but as I now understand Mr. Stanley Williams to state that he still sees the canals of Mars double after taking every care that the focussing is correct, I feel that this explanation can no longer be urged.

For some time past and after hearing Mr. Williams's last paper, I have been gradually forced to the conclusion that whilst the drawings which show these duplications accurately represent

what the various observers saw, the explanation of the faculty which enables them to see these double lines must be sought for in some rare physiological difference in the eyesight which these astronomers possess, or, in other words, the doubling of the canals on Mars is really a subjective and not an objective phenomenon.

Otherwise how can we explain the fact that whilst a select number of observers using telescopes of moderate aperture constantly see these duplications, a much larger and equally experienced number of observers, some of whom use the largest telescopes in existence, fail to trace any duplicity at all.

One other point I would like to mention in support of my contention. I think it will also be found that the observers who see double lines on Mars have also the faculty of seeing faint and delicate streaks or lines on other celestial bodies. I have in my mind at this moment a remarkable map of the floor of the Lunar Ring-plain Ptolemaus, by Mr. Stanley Williams, in which he depicts the interior of this formation as being covered with a network of fine bright streaks numbering in all about 84.

The details of this chart are given in an article in the XXI. Vol. of the "Astronomical Register."

Now this formation is one which has been receiving a good deal of attention from the members of the Lunar Section of this Association for some time past, and as a consequence I have received a good many drawings and descriptive notes from different observers, but in no case have any of them described anything approaching what Mr. Williams has depicted. I can only assume, therefore, that the ability to see faint linear markings of this nature, even on the moon, is one which is possessed by very few individuals. So far as my own observations and those of other people go, there are only two light streaks on the floor of Ptolemaus, and these are not difficult objects; one runs from A to the S wall, and the other crosses this near its middle in a crescent-like form from S.W. to N.E.

I have recently been favoured through the courtesy of the Director with a copy of the Annals of the Observatory of Harvard College, Vol. 32, Part 2, Prof. W. H. Pickering. In this publication there is one chapter dealing with the telescopic appearances of various markings on artifical disks. A sub-division of this chapter is devoted to a consideration of the telescopic appearance of fine parallel lines, carried out as Prof. Pickering states in order to investigate the question of the reality of the duplication of the canals of Mars.

In the result, Prof. Pickering is led to the conclusion that "the capacity for seeing the duplication distinctly is a personal one."

The details of the investigation are extremely interesting, but the description is too long to repeat in extenso. I will, however, as briefly as possible, endeavour to put the salient points forward, more especially as in all probability, but very few of the Members will have the opportunity of reading the original article itself. An artificial disk was made upon which several pairs of fine lines were ruled, and these were examined by the telescope at a given distance; it was found in practice that if the centres of the lines

were 0·8 mm. apart, their duplication would certainly be discovered under favourable atmospheric conditions, but if not more than 0·6 mm. apart, it would not be discovered under any circumstances, in the latter case the appearance was indistinguishable from that of a broad pencil-mark half as wide again as the double line, and of suitable blackness. Fine dark lines were easier to separate when the seeing was good, but somewhat coarser lines were easier when it was poor. Under the most favourable circumstances the least separation that could be discovered by inspection was 0·7 mm., which would correspond to 0″·42. The telescope used was of 15-in. aperture, and consequently capable, according to Dawes' formula, of dividing stars as close as 0″·30 apart.

One interesting result in this connexion is shown by Prof. Pickering, namely, that fine parallel lines must be about 50 per cent. wider apart for their duplicity to be discovered by the telescope than would be the case for double stars, that is, when the telescope is tested to its utmost capacity. When conditions of seeing are not of the best, the telescope will only separate double lines that are twice as wide apart as the distance which separates a double star seen under the same conditions. Or to put the case in the form of an example;—a telescope that will separate stars half a second apart will, under poor conditions not separate parallel lines less than one second apart.

Prof. Pickering goes on to discuss the observations of Mars by Schiaparelli in 1882. The telescope Schiaparelli used was of 8·5-in. aperture; therefore, according to the foregoing not able to resolve double lines of less than 0″·81 to 1″·08 apart, and depending upon the distinctness with which they were visible. The diameter of the planet was 15″·5; therefore, one degree on its surface at the centre of the disk would subtend an arc of 0″·135. No duplication could consequently have been discovered when the separation of the components was less than from 6° to 8°. Prof. Pickering then points out that on examining the Schiaparelli maps, he finds nearly all the double canals are separated by distances of 6° to 8°, and, therefore, just on the limit of visibility, two canals are as much as 9° apart, and a few are a little closer than 6° apart.

Now comes a remarkable point to which the Professor calls attention.

In 1886, Schiaparelli was able to use a telescope on Mars of 19-in. aperture instead of the 8½-in. of 1882. At this time (1886), the diameter of Mars was 15″·4 as against 15″·5 in 1882, or practically the same, and Schiaparelli's illustrations, instead of showing the canals separated by the same distances, that is, from 6° to 8° as in 1882, show them as being separated by about half that distance, viz., 3° to 4°, with a few as wide as 5°, this last being the maximum width shown. Thus the extraordinary result is, that, with an increase of aperture twice as great, the separating distance is reduced to one-half. It appears to me astonishing that, when the aperture increases, the width separating the lines diminishes in exact ratio; or, to reverse the operation, the smaller the aperture the greater the distance separating the lines. If Prof. Pickering's conclusions are sound, and there seems no other interpretation possible of the figures and data which he gives, we

may fairly assume that if we only increase the aperture of the telescope sufficiently, we shall arrive at a point when the two lines will merge into one. If this assumption is correct, it will explain why the giant telescopes do not show any double canals at all. Prof. Pickering is not content to base his views on the observations of Schiaparelli alone, but he proceeds to investigate those of later date made by MM. Flammarion and Antoniadi, and also those made at the Lowell Observatory, and in each case he finds the results are the same, viz., that the width separating the canals was in close agreement with the theoretical capacity of the telescope used for dividing fine lines. The Juvisy telescope is of 9·5-in. aperture, and theoretically capable of resolving double stars as close as 0″·48 apart, or lines 0″·72 or 0″·96 apart, or a mean distance of 0″·84. Now, the average distance separating the canals by this instrument is given as 0″·88, which closely agrees with the theoretical limit. Again, in the case of the Lowell telescope, it should resolve lines 0″·28 to 0·″38 apart, and the published results show the mean distance of the components as being 0″·31, also a very close agreement.

In conclusion, may I quote Prof. Pickering's own words? He says:—"Although I have never seen the canals double myself, "I have examined them when others declared they were double. " . . . . If the duplication of the canals were merely sub- "jective and dependent upon some personal peculiarity, there is "no reason why it should not be seen in comparatively small "telescopes quite as well as in larger ones. On the other hand, "if the duplication is real, it should, under equally good atmos- "pheric conditions, be very much better seen in a large instrument "than in a small one. Heretofore, however, quite as many "duplications have been detected with telescopes of 6 to 10 "inches in diameter as have been found with much larger instru- "ments. . . . . These facts lead me to the belief that the "capacity for seeing the duplication distinctly is a personal one "which some observers possess and others do not.

"The true appearance of the canals is, according to my belief, "owing to the properties of light itself, always that of single "hazy bands, the supposed duplication arising only when the "bands become unusually narrow and distinct. This additional "distinctness may arise either from seasonal changes upon the "planet, rendering them darker, or, in the case of the majority "of observatories, from occasional favourable atmospheric con- "ditions, which latter cause would naturally lead the observer to "believe that the phenomenon observed was genuine."

Six Suggestions for Observation of Partial Phase of the coming Solar Eclipse.

By the Rev. S. J. Johnson, M.A., F.R.A.S.

A solar eclipse, in which the obscuration is barely three-fourths of the diameter in the more favoured S.W. counties of our land, diminishing to one-half about the Orkneys, does not present opportunity for valuable observations, except, perhaps, as to determining the instants of first and last contacts, where the time is known to within a second or so, and the latitude and the longitude are also accurately known.

Nevertheless it presents opportunity for an interesting observation to the large and increasing number of amateurs, and this from the fact that we have had nothing of the kind for 30 years. The 29 years 1871 to 1899 inclusive, do not afford an eclipse covering more than about a third of the sun. The 29 years 1900 to 1928 present seven eclipses, in which more than two-thirds of the sun are obscured, culminating in 1927 with totality for a few seconds on a line drawn from about Aberystwith to Whitby. This does not take account of that of 1916, when the sun sets three-fourths obscured in the west of England, and the S.W. corner of Ireland is within 150 miles of the point where the sun goes down totally eclipsed.

Perhaps amateur observers may like to be reminded of the following points on which observations may be made in Great Britain on May 28:—

(1.) *Notice Times of First and Last Contacts.*—The contact of limb should be sharp and distinct. It would be well for anybody who draws up notes of his observations to state by what method his time is obtained.

(2.) *Notice any Irregularities in the Dark Limb of the Moon.*—This is generally an object of interest in a partial eclipse. Do the cusps appear sharp, or, on the other hand, blunted, owing to such irregularities?

(3.) *Especially Notice if any part of the Black Disk of the Moon can be seen outside the Sun.*—In a clear sky, I have generally seen this, notably in 1882. How far can the moon be so traced, say 1′ or 2′ of arc? Possibly the moon is so rendered visible by being projected against the solar corona.

(4.) *The Globular Form of the Moon when superposed on the Sun is worth noting.*

(5.) *The Earliest Visibility of Venus with the naked eye should be noted.*—It is nothing remarkable to notice the planet in the daytime, but on May 28th the planet is not so far from its greatest elongation. The spectator must carry his gaze about 45° to the east of the sun, and ought readily to pick it up. In 1905 Venus is not so far from the sun, and in 1912, when 11 digits of the sun's diameter are obscured, as seen from the south coast of England, the planet is very near him, and will hardly be caught by the naked eye.

(6.) *If the Sky is clear, the Sunlight will probably be slightly affected*, becoming a little more dull and lurid about the time of the greatest phase. More than this cannot be expected in 1900 and 1905, but in 1912 the lurid dimness overspreading the landscape will be remarkable.

As to (5) it may be remarked that the eclipse of A.D. 540 (which the late Dr. Hind remarked to me, puzzled him much, its magnitude in England being only the same as in the coming eclipse of May 28), is described in the "Saxon Chronicle" as being "on the 12th of the Calends of July, and in which the stars "showed themselves full nigh half an hour after nine." Still, if Venus was seen, it seems sufficient explanation.

The Proper Motion of Stars.

By Gavin J. Burns, B.Sc.

In the recently published "Photographs of Stars," by Dr. Roberts, attention is called to the fact that often no more stars are depicted on a plate after several hours exposure than on a plate exposed for only an hour-and-a-half. Dr. Roberts considers that the evidence founded on these photographs may be accepted as demonstrative "that the part of the starry universe visible "from the earth is limited in extent."

Now, it must be observed that such evidence is only demonstrative on the hypothesis that there is no absorbing medium in space. If light is absorbed or otherwise lost in its journey from the stars to the earth, we have exactly the same result.

It is, therefore, important to obtain independent evidence on the subject. The proper motion of the stars affords a means of doing so. It is obvious that if the stars thin out as the distance from the earth increases, the number of stars having a large proper motion will be relatively great.

In order to test this point, I have made the following analysis of the proper motions of the stars shown on the late Mr. Proctor's charts published in the "Monthly Notices" for 1872. The unit of time is 36,000 years:—

Amount of Proper Motion.	No. of Stars.	No. of Stars having a Greater Proper Motion than shown in First Column.	Nos. in preceding Columns Multiplied by 7.
33° to 70°	5	—	—
17 to 32	5	5	35
9 to 16	15	10	70
5 to 8	59	25	175
2 to 4	164	84	588
1 to 2	426	248	1,736
½ to 1	785	674	4,718
0 to ½	55	—	—

It may be readily shown that, if the stars are distributed in space with approximate uniformity, and if the real motion is everywhere the same on an average, the number in the second column of the preceding table should be about seven times the total entered in the third column, assuming that the number in the second column gives the actual number of stars having the given proper motion. The number resulting by the multiplication by seven is given for the sake of comparison.

Our very imperfect knowledge of the actual proper motions of the stars accounts to a very great extent (perhaps altogether) for the comparatively large number of stars known to have a large proper motion. The last two or three lines of the above table

may be left out of account altogether for this reason. But is it likely that the large deficiency in lines three and four will be made up by future observations? Again, I do not think that the distribution of proper motion among the first ten stars in the list can be merely due to accident.

So far as the evidence derived from known proper motions is of value, it is, of course, entirely in accordance with the hypothesis of a limited stellar universe.

The Zodiacal Lights and Gegenschein.

By FRANCIS J. BAYLDON, R.N.R.

(*Extracted by Walter F. Gale.*)

The following are extracts in full from a lengthy paper by Mr. Bayldon, which was communicated by Mr. G. H. Halligan to the New South Wales Branch of the Association at its Meeting, 1899, June 19.

As great attention is now being given to the Zodiacal Lights, the following remarks, which are based entirely on my own observations, may prove of interest to other observers. The observations have been made at sea in all latitudes from 55° N. to 55° S. and extend over the last two years. I find that in the clear air at sea the Lights are seen to much greater advantage than from most places ashore, and I may here remark that a seaman keeping his watch on deck has considerable advantages over the ordinary observer, in that he stays in the open air for several hours free from the glare of lights, and being accustomed to the darkness he can more readily discern the faintest diffused light. My attention having been given to the study of the subject, in the first instance, chiefly to pass away an otherwise tedious watch on deck, I unfortunately made very few notes, hence the details of measurements given in this paper must be regarded as careful approximations only. Up to the time of writing these remarks I had not had access to the literature of the subject, and although I well knew the "opposition glow," I had never heard of the term "Gegenschein," so my observations, at any rate, are unbiassed by previous knowledge. I wish to heartily thank my brother officer, Mr. Reg. Bailey, for his kindly assistance in many ways, even though Kipling's "Very latest" had to be forsaken for a few minutes.

The cones of the Zodiacal Light are generally composed of milky white light, remarkably soft in appearance, which is especially noticeable when brought into favourable contrast with the steely white of the Galaxy or the hard first signs of moonshine. Occasionally faint tints of colour can be traced—pink, yellow, green—but this is seldom, and appears to be entirely due to atmospheric conditions. On three or four occasions I have seen the western cone composed entirely of pink light to an altitude of 50° and forming a most beautiful spectacle against the background of faint blue sky. The brightness of the Light depends to a great extent on the clearness of the atmosphere. At maximum it exceeds the brightness of a third-magnitude star, or

rather a third magnitude star would be lost on the bright background. The brightest portions frequently surpass those of the Galaxy, and are often to be seen before it in the evening and after it in the morning. From the brightest portion the Light fades off into almost indefinable luminosity. The bright cone is frequently bounded on both sides by a few degrees of faint luminosity, which increases in extent as the cone decreases towards its apex and continues still further, visible only in the clearest atmosphere, as a faintly luminous zodiacal band from 15° to 8° broad. About the time of the winter and summer solstices it can be traced right through opposition until it joins the eastern cone, but at the equinoxes I have not traced it within 15° on either side of opposition. A notable feature is that soon after the solstices—towards the end of December and June—when the Galaxy is sufficiently removed from opposition, that portion of the luminous band which is in opposition is seen to be extended into a roughly oval shape, with a slight increase in brightness. It generally occurs that the connecting band itself cannot be traced to opposition on account of the Galaxy, so that it then appears to be a totally separate luminosity. This is, I believe, what is known as the "Gegenschein." In extent it is from 10° to 15°, of an oval form, fading away into faintest luminosity with vague boundaries. It lies in direct opposition in Gemini and Sagittarius, a few days after the solstices, and slightly to the westward of this position a week or two later, in January and July.

The breadth of the connecting band varies from 15° to 10° on very clear nights, though frequently it can only be seen about 8° to 4° broad, and it also appears to become more irregular as the Gegenschein is approached. A very clear atmosphere is necessary in order to see it throughout the night. Generally, owing to increased saturation as the night advances, the band can be traced very little further than the bright apex of the cone. The eastern branch is often rendered invisible from the same cause, and as the sky is usually more or less cloudy after midnight, good observations of it are rare. In addition it is far easier to trace the faint band from its brighter source at the western cone than it is to pick it out if the cone is obscured by clouds or haze. But on really clear nights it can always be traced by a keen-sighted observer. The distance to which it may be seen varies with the season of the year, for the brightness of the band is not constant.

The breadth of the cone varies very much, especially for the first 15° or so above the horizon, where it may be anywhere between 15° to 50° broad. This, I believe, to be greatly due to atmospheric conditions, so that observations below 20° altitude are almost worthless. The average of my observations at 20° altitude gives a breadth of 22° for an elongation of about 40°. At the apex, altitude about 75°, elongation about 105°; the average breadth of the brighter light is 7°, and the total breadth of luminosity 18°. It is noticeable that as the cone sets and is followed by the band, the band also assumes a cone shape of nearly the same proportions as the previous bright cone, though very much less in intensity.

To a casual observer it might thus appear that the cone did not set, but simply became less bright. A comparison with the atmospheric effects on the Galaxy is extremely interesting. At times the Galaxy is seen as a cone of diffused light, its base sometimes appearing double its normal breadth. At other times it shows intense brightness at high altitudes, and is entirely indistinguishable for the lower 20° above the horizon. The cone formed by the Galaxy differs remarkably from that formed by the Zodiacal Light in two ways; its outline is irregular, and its light is nearly uniform.

The elongation of the apex of the Light I have determined as 105 ± from the sun. Under especially favourable conditions of weather and latitude I have seen the western apex at an altitude of 80°, and subsequently the eastern apex at a similar altitude above the horizon.

At other times, particularly about the equinoxes, the Light fades away so generally and gradually, that the brighter cone is not discernible, in which case the whole luminosity appears to come to an apex at an elongation of 150 ±.

My observations of the line of central axis show that the plane of the Light is inclined approximately 4° to the ecliptic, with the ascending node near longitude 0°.

There is an important modification to this inclination of 4° in that as the observer goes towards the N. the line of central axis is displaced towards the *North*, while if he journeys S. the displacement is towards the *South*. The amount of displacement appears to me to be about 1° for every 20° of latitude. It seems to be greatest at small elongations, as at the base of the bright cone, and appears to decrease as the elongation increases. I believe, therefore, that if an observer on the equator were able to mark on the sky the axis as he sees it in red, and observers in, say latitudes 50° N. and 50° S., in green and yellow, none of these axes or outlines would agree.

The northern observer would determine the axis to the N., and the southern observer to the S. of that seen from the equator, and this one (if visible) would show a true parallactic displacement to the observer in high latitudes.

I have formed a theory as to the constitution and nature of the zodiacal light, but will withhold its publication in your "Journal" until it has been further tested, when possibly it may be deemed worthy of space.

Before concluding, may I add that a number of observations have been obtained of zodiacal cones, evidently due to the moon. Three or four days after and before new moon, I have noticed the zodiacal light become visible in the moonshine and twilight, a vague sheen between the moon and horizon, quite different to ordinary moonlight, being apparently due to her light. A day or two before first quarter the moon is so bright that probably most observers would think it useless even to look for the western zodiacal light, but in very clear air a peculiar aspect is presented which calls for special attention. Around the moon, when at an altitude of, say, 50°, there is to be seen the same vague sheen I have mentioned.

At times no definite boundaries can be assigned to it, but occasionally it can be traced downwards with a breadth of about 25°, its centre coinciding almost, if not exactly, with the apparent central axis of the zodiacal light, although the moon may not be on this central line. More rarely I have seen a still more remarkable feature, so give a recent actual observation, made when on the equator, 1899, May 17, 9^h to 11^h.

The moon was at first quarter in latitude 4½° S., longitude 153°, the sun's longitude being 57°, and the moon's altitude between 60° and 30°, above the western horizon. An immense blunted cone was formed by the sheen, with the moon situated at its broadest part, which then slightly tapered again towards the horizon. The apex of the cone was very blunt, 15° broad and about 35° above the moon, where the maximum breadth of 46° was reached. It contracted to 44° just above the horizon. I could trace these outlines for more than an hour, but as the moon's altitude became small, she caused too bright a glow for the cone to be visible.

The central axis corresponded to the ordinary central axis of the light, as it would have appeared had no moon been shining, but the moon herself was clearly seen to be displaced to the S. of the axis.

The outlines of this immense cone I find correspond to the maximum boundaries of the light which I have obtained from time to time in high N. or S. latitudes, and are fully double the extent usually seen at these elongations.

As bearing on the matter also, I have noted that Venus appears to intensify the light of the cones when she does not altogether overwhelm them with her lustre. Jupiter, with an elongation of less than 90°, appears to have the same effect.

Sydney, 1899, June.

Total Solar Eclipse of May 28th, 1900, in Central Spain.

By A. M. W. Downing, M.A., D.Sc., F.R.S.

1. Talavera de la Reina :—

Adopted position - - { 4° 50′ W. longitude. 39° 55′ N. latitude.

		d	h	m	s
Eclipse begins - - -	May	28	2	35	
Totality begins - - -			3	52	15
Totality ends - - - -			3	53	21
Eclipse ends - - - -			5	1	

These are Madrid Mean Times.

	Angle from North Point.	Angle from Vertex.
First Contact - - -	273°	221°
Second „ - -	53°	359°
Third „ - - -	313°	259°
Fourth „ - - -	93°	37°

2. Navalmoral de la Mata:—

Adopted position - - $\left\{ \begin{array}{l} 5^\circ\ 34'\ \text{W. longitude.} \\ 39^\circ\ 52'\ \text{N. latitude.} \end{array} \right.$

	d	h	m	s
Eclipse begins - - -	May 28	2	34	
Totality begins - - - -		3	51	27
Totality ends - - - -		3	52	54
Eclipse ends - - - -		5	1	

These are Madrid Mean times.

	Angle from North Point.	Vertex.
First Contact - - -	273°	221°
Second ,, - - -	99°	45°
Third ,, - - -	267°	213°
Fourth ,, - - -	93°	37°

Madrid Mean Time is $14^m\ 45^s$ earlier than the corresponding Greenwich Mean Time.

The sun's altitude at totality is 39° for both stations. Observers are warned that, judging from the results of recent total Solar Eclipses, the above durations of totality are, perhaps, as much as three seconds too long.

Correspondence.

The Coelostat.

In No. 5 of the present volume of the "Journal" the Rev. C. D. P. Davies makes some inquiries concerning the Coelostat. As my paper in "Monthly Notices," Royal Astronomical Society (LVI., No. 8), seems to be less clear than I hoped, perhaps I may attempt to explain one or two obscure points further.

1. The mirror need only be parallel to the polar axis (except for a detail of practical convenience), and may be any distance in front of or behind it. If Mr. Davies will think for a moment of other plane reflecting surfaces used in astronomical observation he will be satisfied of this. An artificial horizon, for instance, need not be at any particular height; so long as the surface is horizontal, that is all that is required *theoretically*. Practically it must be in a certain position because it is of finite area, and the telescope will not get the benefit of it if it is put above or below certain limits. So with the Coelostat mirror; if it were of unlimited area it could be put any distance in front of or behind the axis of rotation, but a finite mirror is most useful near the axis; otherwise as it turns round, the (fixed) telescope will point past the edge of it.

2. The suspension of the mirror was arranged by Dr. Common, who has given some attention to this matter. The mirror is about two inches thick. I see, however, that in my paper I have scarcely made clear what was done. The mirror is held by three lugs screwed up into a groove. Before screwing the adjusting

screw these lugs were loosened, and after adjustment they were tightened. I did not mention this loosening and tightening in my paper, leaving it to be naturally inferred.

3. The use of the declination theodolite near the ground is facilitated by a diagonal eye-piece. I have never found any discomfort in observing with it.

4. The essential difference between the heliostat and coelostat is that with the former the reflected beam can be sent in any required direction; but in all cases the image slowly rotates round its centre. Only the central ray is really constant in direction, the others rotate round it as circumpolar stars rotate round the Pole. With the Coelostat, on the other hand, the whole sky (or such portion of it as can be seen in the mirror) remains fixed; but to see any particular star the telescope must be placed in a definite position, or rather one of a series of definite positions; its position is not entirely arbitrary as with the heliostat.

5. As regards the adjustments, I may, perhaps, add a word or two more. They are only two—the adjustment of the mirror parallel to the axis and the adjustment of the polar axis. (There is no adjustment required for the telescope, it is simply pointed at the required star by eye. In eclipse work the sun is caught on the ground glass as with an ordinary camera.) The adjustment of the mirror has been carried out on the lines indicated in my paper by supplying two or three short adjusting screws in place of the long ones used for letting the mirror down into its cell; and experience has shown that the adjustment can be easily made. With regard to the adjustment of the polar axis, this is the same as for any equatorial, and there is really nothing new to say, except that possibly some observers may not have realised how much may be done without an astronomical observation at all, and may not be prepared to make the most of a casual glimpse of the sun at a time when it is important to do so. In 1887 I had to get ready for an eclipse with one hour of the sun only during the week preceding. We did not see the eclipse, but if we had, that brief hour was all that was available of sun or stars for adjustment. So it is well to be prepared to take advantage of such an opportunity.

Suppose then we have an equatorial of any kind to be adjusted. Strap a level firmly to the telescope parallel to its line of collimation. (In the theodolites for adjusting the coelostats such a level is part of the instrument.) Parallelism is not essential, but is convenient; it need only be approximate in any case.

Now point the telescope on the meridian (supposed known *roughly*) so that the level is horizontal and read the declination circle, getting the reading—R_1. (If the circle is graduated so as to give N.P.D., or in some other way, the declination can be deduced.) Turn the instrument through 180° in hour angle, and again make the level horizontal and call the declination $-R_2$. Then $\frac{1}{2}(R_1+R_2)$ is the instrumental colatitude, and if it does not agree with the known colatitude of the place, the axis must be elevated or depressed until it does.

It may be remarked that there are altogether four positions in which the telescope may be placed horizontal on the meridian; but only two of these in which the level is available for reading,

which are the two to be selected; in the other two it is upside down.

Now having got the altitude right, suppose the sun comes out. If he is very near the meridian we cannot do much, but even an hour from the meridian will give a fair adjustment in azimuth. All we have to do is to point the telescope at the sun and read the declination S_1; reverse in hour angle and read again S_2; then $\frac{1}{2}(S_1 + S_2)$ is the instrumental declination, and if it agrees with the known declination σ of the sun, the instrument is right in azimuth and fully adjusted. If it does not, move it in azimuth until it does. The rule for direction is this: if $\frac{1}{2}(S_1 + S_2)$ is greater (algebraically) than σ, the instrumental pole is too near the sun and must be moved away from it; hence, if the observation is made in the morning the pole must be moved to the West, if in the afternoon to the East.

If it is moved much, the altitude observation with the level should bo repeated; and then if alteration in altitude is required, the azimuth observation repeated until good adjustment is secured

H. H. TURNER.

[Since the above was written an admirable paper by M. A. Cornu, entitled "On the Law of Diurnal Rotation of the Optical Field of the "Siderostat and Heliostat," has appeared in the "Astro-Physical Journal," for March 1900, p. 148.—H. H. T.]

Venus, seen at Mid-Day.

At noon, on the 4th of April, while standing in the streets of our City waiting to see the entry of the Queen, I happened, quite innocent of any astronomical thought, to look up at the sky. There I saw Venus quite plainly. The planet was of a brilliant white, and nearly as visible as after 6 o'clock any of these evenings. She was close to the edge of a thick cloud, which, for a moment, had obscured the sun. Elsewhere, the sky was intensely blue and clear. A couple of hours later I again caught sight of her in a rent of cloud. The previous day had been very wet. At noon, on the 5th, I looked carefully for the planet, but in vain, as a slight haze overspread the sky.

Dublin, April 16, 1900. CECIL G. DOLMAGE.

Black Monday.

I quote from Brewer's "Dictionary of Phrase and Fable" (edit. 1898):—

"Easter Monday, April 14, 1360, was so called. Edward III. was with his army lying before Paris, and the day was so dark, with mist and hail, so bitterly cold, and so windy, that many of his horses and men died."

The following lines are copied from Chambers' "Book of Days":—

"It is to be noted that the 14th day of April, and the morrow after Easter Day (1360) King Edward [III.] with his host lay before the City of Paris; which day was full dark of mist and

hail, and so bitter cold, that many men died on their horsebacks with the cold; wherefore unto this day it hath been called the *Black Monday*."—"Stow's Chronicle."

Now, if *the 14th day of April is the morrow of Easter Day*, Easter Day is the 13th day of April.

Now, as it is easy to verify during the reign of King Edward (III.) (1327–1377) Easter fell on *the 13th day of April* in the years 1343, 1354, 1365, 1376. In the year 1360, Easter was celebrated on the 5th of April, therefore, the date in Brewer's and Chamber's quotations, seems to me not to be the right one.

I should be thankful, interested as I am in the question, if a reader of your most valuable periodical, would kindly afford an explanation, of the mentioned (very likely inconsistent) inexactitude.

Torino (Italy), OTTAVIO ZANOTTI BIANCO.
Via della Rocca 28.

[It would appear that Brewer and Chambers have both altered the reckoning from Old Style to New Style. Easter Monday fell in 1360, on April 6, Old Style, as Sig. Bianco points out, and the difference between the styles would have been eight days, if the New Style had been adopted at that time.—EDITOR.]

Notices of the Association.

The ordinary Meetings of the Association will be held on May 30, and June 27.

Official.

The Council regret to state that Mr. William Schooling, F.R.A.S., has been compelled by pressure of business to resign the Secretaryship of the Association.

MR. A. C. D. CROMMELIN, F.R.A.S.,
"Benvenue,"
Ulundi Road,
Blackheath,

has kindly consented to fill the vacant place, and the Council have therefore great pleasure in appointing him Honorary Secretary.

Editorial Change of Address.

The Editor asks Members to kindly note that his address in future will be—

MR. E. WALTER MAUNDER, F.R.A.S.,
86, Tyrwhitt Road, S.E.

He would be obliged, however, that all communications for him during the current month, whilst he is absent at Algiers, should be addressed to the care of the Assistant Secretary, 26, Martin's Lane, Cannon Street, E.C.

Total Solar Eclipse of May 28, 1900.

Members wishing to observe the Eclipse from some station in Portugal are recommended to communicate with Mr. G. F. CHAMBERS, F.R.A.S., Northfield, Eastbourne, Sussex.

Those wishing to observe in the interior of Spain, or at Algiers, may procure necessary information from Messrs. T. Cook and Son, Ludgate Circus, E.C.

Members wishing to undertake shadow-band observations are requested to adhere as far as possible to the programme drawn up by Mr. E. W. JOHNSON, 50, Birdhurst Road, South Croydon, published on page 164 of the "Journal," and to communicate their results to him after the Eclipse.

Mr. H. KEATLEY MOORE, Chipstead, Chepstow Rise, East Croydon, has kindly consented to give general advice and assistance to Members intending to take part in sketching the corona, and will be pleased to receive sketches after the Eclipse is over.

The "Eclipse Suggestions" printed in the "Journal," Vol. X., No. 4, have been reprinted in separate form, and copies can be obtained by Members on application to the Assistant Secretary, Mr. T. FRID MAUNDER, 26, Martin's Lane, Cannon Street, E.C.

Variable Star Section.

The following letter has been received by the Director of the Variable Star Section:—

3, St. Mary's Road, Pembroke,
Dublin, March 28th, 1900.

DEAR SIR,

MANY thanks for the beautiful volume of photographs, which arrived safely this morning.

Please convey my best thanks to the Members of the Variable Star Section who have so kindly presented it to me. I shall highly value it.

Yours faithfully,
(Signed) J. E. GORE.

The book presented was the 2nd Vol. of Dr. Roberts' selection of Photographs of Nebulæ, Star Clusters, &c., which was done "in recognition of his services as Director of the Section during "a period of nine years, 1890–99, in which each member has "received from him much valuable help and encouragement "in the observation of Variable Stars."

There were eight subscribers.

E. E. M.

Queries.

It is requested that queries be written on one side of the paper only, and each query on a separate sheet.

Queries may either be placed in the Query Box at the Meeting, or may be sent to the Hon. Secretary, Mr. A. C. D. Crommelin, F.R.A.S., Benvenue, Ulundi Road, Blackheath, S.E.

Candidates for Election as Members of the Association.

25th April 1900.

John Waller Lawrence Child,
Vernham, Merton Hall Road, Wimbledon.
Proposer—Julia L. Child. *Seconder*—Louis C. Roden.

Lady McClure,
Redford House, Colinton, Midlothian.
Proposer— Ralph Copeland. *Seconder*—Thomas Heath.

Miss Jessie McRae,
32, Birdhurst Road, Croydon.
Proposer—Ernest W. Johnson.
Seconder—Thos. Frid Maunder.

J. O'Callaghan,
Slindon Cottage, Arundel.
Proposer—John S. L. Long.
Seconder—Rowland H. Wedgwood.

Andrew Rowan,
Fircroft Road Board School, Upper Tooting, S.W.
Proposer—J. R. Jack. *Seconder*—J. G. Petrie.

William Henry Walmsley, B.Sc., F.R.A.S.,
Nautical Almanac Office, 3, Verulam Buildings, Gray's Inn, W.C.
Proposer—Philip May. *Seconder*—Edward W. Maunder.

Edward Weldon,
Didmarton, Tunbridge Wells.
Proposer—H. P. Hollis. *Seconder*—Andrew C. D. Crommelin.

New Members of the Association.

Elected, 28th March 1900.

Sir Thomas S. Bazley, Bart., M.A., J.P., D.L., Winterdyne, Bournemouth West.

Otto Hoffmann, Budapest, V. Nádor Utcza 12, Hungary.

Rev. Augustin Morford, St. Mary's, Poole, Dorset.

G. Rossall Pearson, Stafford House, Halifax.

Capt. Frank William Raisin, R.N.R., 6, Reservoir Road, Hatcham, S.E.

David Chisholm Simpson, 199, Camberwell Grove, Denmark Hill, S.E.

North-Western Branch.

New Member of the Association.

Elected 7th March 1900.

Herbert Bury, B.A., Wallington, Swindon Park, near Manchester.

West of Scotland Branch.

NEW MEMBER OF THE ASSOCIATION.

Elected 16th February 1900.

DR. JAMES LAMBIE, Lowick, Beal, Northumberland.

Additions to the Library.

Lockyer.—Recent and coming Eclipses.
Aldis.—On the Numerical Computation of the Functions $G_0(x)$, $G_1(x)$ and $J_n(x-\sqrt{i})$.
Huggins.—Atlas of Representative Stellar Spectra, Vol. I.
Knowledge.—Vol. XXII.
Astrophysical Journal.—Vol. X.
Publications of the Astronomical Society of the Pacific, Vol. XI.
Lynn.—Remarkable Comets, 8th Edition.
—— Remarkable Eclipses, 5th Edition.
Harvard College Observatory.—54th Annual Report.

The Library Catalogue (including additions to the end of last Session) will be forwarded by the Hon. Librarian on receipt of *1s. 1d.*

Queries.

Reply to Query No. 63.—The occultation of Lalande 28,213 was observed at the Royal Observatory, Cape of Good Hope, on 14th August 1899. If this is of any use to your correspondent, Dr. Gill will no doubt send particulars on application.

Query No. 65. VENUS DURING THE ECLIPSE OF THE SUN.—Mr. Crommelin states ("Journal," Vol. X., p. 171) that "Venus at its greatest "brilliancy in the middle of Gemini will be visible with the naked eye "before the eclipse begins at all." If so, it must be visible here in England, and all day long. Is Venus ever visible to the naked eye in the middle of the day, and within one sign of the sun?

Reply.—Venus is frequently visible to the naked eye in England in full sunshine, about the time of her greatest brilliancy. Although short-sighted, I have frequently so seen her, with the aid of *pince-nez* only, and can, therefore, speak with confidence. Of course a very clear sky is necessary, and one must know exactly where to look. Venus can never be more than 1½ signs from the sun. (*See* also page 266.)

A. C. D. C.

Query No. 66. THE ZODIACAL LIGHT DURING A SOLAR ECLIPSE.—Has the Zodiacal Light ever been seen at a total eclipse of the sun, and, if not, why not?

Reply.—No; unless Prof. Newcomb's observation of the great equatorial extensions of the corona during the eclipse of 1878 be

taken as being a case in point. It should be remembered that a moon two days old, is sufficiently bright to overpower the Light, and that the total light of the corona is often much greater than that of the full moon. On the other hand, the Zodiacal Light nearer the sun is probably brighter than at an elongation of 30° from it. It should, therefore, be sedulously looked for in all total eclipses, small as the chance of success appears to be. Possibly the eclipse of 1901 with its 6½ minutes of totality may give the necessary opportunity.

Notes.

THE ROYAL ASTRONOMICAL SOCIETY.—The ordinary Meeting of the Society was held on Friday March 9. Mr. E. B. Knobel, *President*, in the Chair. The *Secretary* read the list of presents received, laying especial stress on a section of Dr. Weinek's "Photographic Atlas of The Moon," and on the magnificent volume by Sir William and Lady Huggins, the result of their work on stellar spectra. The *President* then drew attention to another valuable present in the work of Albategnius, translated by Prof. Nallino, of the Milan Observatory. *Mr. Newall* read a paper by Prof. Keeler on photographic observations of Hind's variable nebula in Taurus. The *President* remarked on the curious fact that this nebula originally discovered with a 7-in. O.G. in the early fifties, should have been subsequently invisible in powerful telescopes, and should have now been photographed, but that its position did not seem identical with that recorded by Hind. *Mr. Dyson* read a paper by Mr. C. T. Whitmell on the "Maximum Duration possible of a Total Solar Eclipse," which was of interest in prospect of a 6-minute long eclipse visible in Sumatra in 1901. He pointed out that for maximum totality five conditions must be fulfilled which, however, could not all be fulfilled simultaneously. *Mr. Crommelin*, the *President*, and *Mr. Dyson* joined in the discussion. *Mr. Newall* read a paper by M. Antoniadi, describing Saturn on 1899, July 30. *Mr. Shackleton* made a suggestion as to the use of coloured screens in photographing the corona during totality, as Mr. Fowler and Mr. Newall had both pointed out that the image of the corona seen in the "1474 K" line corresponded to an inner corona whose outline did not agree with the corona proper. He suggested that some of the screens used in three colour photography might be found suitable. *Mr. Newall* inquired as to the difference in the length of the exposure needed, and the *President* asked as to the suitability of a liquid screen, which *Mr. Shackleton* thought would distort the image. *Mr. Newall* spoke on the relative strength of the green and the blue line in the spectrum of 1898, and *Mr. Fowler* and *Mr. Evershed* joined in this discussion. *Mr. W. W. Bryant* read a note on a possible occultation of A Geminorum by Venus on 1900, May 27–28 next, which might be used as a means of determining the solar parallax, and *Mr. Dyson* read a paper by Prof. Turner on a simple method of comparing the Bonn "Durchmusterung" and astrographic

plates. *Mr. Newall* read a short note on the binary system of Capella, and the *President* and *Mr. W. W. Bryant* joined in the discussion.

The *President*, Mr. E. B. Knobel, occupied the chair on April 11, 1900. *Mr. Butler* showed a photograph of an exploding meteor secured in 1895 when watching for the Andromedes. The path was somewhat changed after explosion. It was brighter than Jupiter, and its height must have been some 80 miles at the time of explosion. *Mr. Fowler* read a valuable paper on "The effects of stellar rotation and revolution on spectrum lines," in which he discussed the broadening or doubling effects in the cases of dark and light lines respectively. *Mr. Newall, Mr. Crommelin, Mr. Maunder, Mr. Seabroke, Mr. Evershed* and *Mr. Dyson* joined in the discussion. *Prof. Turner* showed a diagram comparing Prof. Thorpe's visual determination of the brightness of the corona in 1893 with that determined from the photographs, and then made some remarks upon his theory of stationary radiants in reply to the objection of Prof. Bredikhine. His theory could only account for the radiants of very ancient lineage, some millions of years, but on the other hand this length of time would perturb the swarm out of its very existence as a swarm. *Mr. Whittaker* also pointed out that whilst it might explain the activity of the radiant earlier in the year, it failed to explain its falling later. *Mr. Dyson*, in response to the invitation of the President to state what observations he proposed to make of the coming solar eclipse, said that the Astronomer Royal would repeat his large scale photographs of 1898, and *Mr. Dyson* himself would take the spectroscope used by Capt. Hills. They were also taking Mr. Davidson, one of the computors at the Royal Observatory, to take photographs for the coronal extensions after the example of Mr. and Mrs. Maunder in India in 1898. He drew attention to the fact that the Royal Mail Steam Packet Company's boats would call at Oporto if a sufficient number of passengers, at least 20, were desirous of landing there for the eclipse. *Mr. Lewis* showed that Dr. See's computation of a five-year period for β 883 was erroneous, and *Mr. A. R. Hinks* described the way they would have reduced the observations of the Leonids at Cambridge in 1899.

LEEDS ASTRONOMICAL SOCIETY.—At the Monthly Meeting held on March 14, a paper was read by the Secretary, Mr. W. D. Barbour, on "Traditions of Creation, as viewed Astronomically." Tracing, briefly, the evolution of man up to the stage of sign-writing, and contrasting the several cosmogonies with which tradition and history have made us acquainted, the speaker dwelt at length upon the Hebrew, as being the one alone capable of a rational and astronomical interpretation. The work of the six days he regarded as a simple story of great events clothed in a framework of simple language adapted to the intellectual childhood of the ancient world; but when critically examined and "read between the lines," was found to contain some not uncertain glimpses of (or rather to imply) an order of great natural occurrences, dating from the period when an underneath crust had commenced to form upon our water-covered globe.

The several prominent questions of "Light," "Firmament," "Dry Land," and "Lights," were severally reviewed, and suggestions thrown out, showing how each might be regarded as not only in the order of natural, but inevitable, events, in the course of earth's development into an inhabitable globe. The origin and evolution of vegetable, animal, and human life, as the main point in the cosmogony, was then dealt with in detail, and shown, suggestively, to be consistent with known facts; always, however, allowing for a Divine, and not a natural, origin of life, science having hitherto conspicuously failed to fathom this seemingly unfathomable mystery. An alternative reading of the Genetic text describing the beginnings of life, was then explained, the results showing that the points in dispute between Mr. Gladstone and Prof. Huxley in 1886, as to the order in creation, really have no existence, except in a plausible, but, in all probability, erroneous interpretation of a portion of the tradition. (The paper will appear in full in the "Journal and Transactions" of the Society.)

THE ACTONIAN PRIZE.—At a Monthly Meeting of the Members of the Royal Institution, held on the 2nd of April, Sir J. Crichton-Browne, F. and V.-P., in the chair, the chairman announced that the managers had that day awarded the Actonian Prize of 100 guineas to Sir William Huggins, K.C.B., F.R.S., and Lady Huggins for their book "An Atlas of Representative Stellar Spectra."

STARS, STAR CLUSTERS, AND NEBULÆ.—Dr. Isaac Roberts, F.R.S., has presented the Association with the second volume of his very wonderful series of photographs with the 20-in. reflector, and it is now in the Library.

The instruments employed to take the photographs were the silver-on-glass reflector of 20-in. aperture and 98 inches focus, and a specially made triple portrait lens of 5-in. aperture and 19·22 inches focus, by Messrs. Cooke and Sons. The reflector negatives measure 10 centimetres square, and one equatorial degree upon these measures 44·2 millimetres, and these are enlarged so that 1 millimetre goes to 30 seconds of arc. The field of the 5-in. lens is 15° in diameter. Certain stars on the plates are marked with dots, numbering from one dot to four or five, and the co-ordinates of these stars are given for the epoch 1900. The plates are arranged in classes or groups so as to indicate apparent physical relationship between them, and the right ascensions are, as far as practicable, given in the order of time within each group. The printed headings on each photograph is S. of the plate, the following side is on the right hand, and the preceding on the left. The photographs themselves are collotype reproductions by the London Stereoscopic Company, and the volume is published at the "Knowledge" office, 326, High Holborn, W.C.

Those Members who can avail themselves of the Library of the Association will do well to study carefully the photographs in these two monumental volumes, for there is no plate that will not amply repay examination. Two plates, especially, we would like

to point out, not simply for their beauty, though that is extreme, but for the character of the nebulæ and stars upon them, and for the light which their study, may throw on the genesis of suns and systems. The first of these is the Nebula H V. 14 Cygni, shown on Plate 21, which, taking a terrestrial analogy, looks like a wreath of white vapour smoke from a passing train, entangled and breaking up in a heavy snowstorm. Taken as a whole, the nebula looks a single arm from a huge spiral of the type in which curved rays emanate from a common centre. Considered in detail the nebula seems to be twisted round itself, in some parts loosely, in some more tightly, like the half unravelled strands of a rope. In many cases the stars seem masked, hidden almost by the nebula, but, as a rule, there seems to be little or no connexion between them.

The second photograph of Nebulæ N.G.C. 1499 Persei, on Plate 22, presents the same character of drifting smoke, but is even more wonderful in appearance. Here, there are two wreaths, parallel to each other, with curling ribbons of nebulosity, and the spaces between these, and between the two wreaths are filled with diffused nebulosity and with processions of stars. In the photograph, we seem to see parts of two coils of a great helix.

These two photographs especially, it will be both instructive and interesting to compare with those taken of the same objects after the lapse of years, or, again, under different conditions of atmosphere and exposure. In some cases, Dr. Roberts has found that, at least under the conditions of the sky at Crowborough, that prolonged exposure does not bring into evidence more stars. In these two cases is it also possible to probe the universe

> " Farther than rebel comet dared
> " Or hiving star-swarm swirled,"

as in the four regions that Dr. Roberts has examined round the great nebulæ of Andromeda and Orion, and round the Pleiades and in the Milky Way in Cygnus? In the case of the Pleiades, only the same faint stars and nebulosity seen upon plates which have had an exposure of 1½ hours are depicted upon those which have been exposed during 10 or 12 hours.

"THE INDIAN ECLIPSE, 1898."—Amongst the many gratifying notices which we have received of "The Indian Eclipse, 1898," two of an especially appreciative character come to us from the United States of America.

The first of these is a paper on "Solar Eclipse Problems," by Prof. George E. Hale, and appeared in the "Astrophysical Journal," Vol. XI., No. 1., January 1900. In this paper, sections 4 and 5, on small scale photographs of the corona, and of photographs of the corona during the partial phase are taken almost entirely from "The Indian Eclipse of 1898," and Prof. Hale adds as a footnote.

"In this connexion one cannot do better than consult the " Report on the Indian Eclipse of 1898, recently issued by the " British Astronomical Association."

An official pamphlet on the "Total Eclipse of the Sun, May 28, 1900," has been prepared under the direction of Capt. C. H. Davis,

Superintendent of the U.S. Naval Observatory, by Prof. H. D. Todd, Director of the American "Nautical Almanac," and Prof. S. J. Brown, Astronomical Director. The work is published as a supplement to "The American Ephemeris, 1900." The suggestions for observations contained in the pamphlet are divided into four heads. The first section on sketches of the corona with the naked eye is reproduced from Mr. Keatley Moore's paper in "The Indian Eclipse, 1898," with the simple substitution of a silver half-dollar for a silver half-crown as giving a standard size for the moon's disk. The third section, on photographs of the corona, is the one treated of most fully. Here the paper proceeds—

"As the results obtained of this eclipse were of such a striking nature and represent in many respects such a distinct advance over any work of that character hitherto done, the suggestions in this paper are confined almost entirely to the material obtained from the Report of the 'Indian Eclipse, 1898'."

Special attention is drawn to the advice given as to exposures for the corona, and to the description of Mr. Cousens' simple home-made device for photographing the sun and following its motion.

Inasmuch as the two highest American authorities have thus expressed their opinion that the Eclipse Report of the Association is the most useful guide for intending observers, it is to be hoped that Members of the Association proceeding to the Eclipse will not fail to provide themselves with a copy. Price, if obtained from the Assistant Secretary, 26, Martin's Lane, Cannon Street, 5*s*., *plus* postage, within the United Kingdon, 4*d*.

MINOR PLANET NOTES.—A.N., 3620–21 contains tables for the computation of the perturbations of those planets whose period approximates to half that of Jupiter, by H. v. Zeipel.

The perturbations are developed in powers of an auxiliary quantity w, which $= 1 - \dfrac{\textit{Twice Jupiter's mean motion}}{\textit{Planet's mean motion}}$.

The perturbations of the first order of (48) Doris are worked out as an example.

A.J. 477 contains an analysis by Prof. Newcomb of the grouping of the orbits of planets (1) to (400) according to their mean motions. Only those whose mean daily motions lie between 500″ and 1,000″ are considered, and these are arranged in groups of 10″, the first containing mean motions between 500″ and 510″, the next between 510″ and 520″, and so on. The following table shows how many planets fall in each of these groups:—

500″ to 600″	-	0, 0, 0, 0, 2, 3, 4, 1, 0, 0.
600 to 700	-	0, 6, 9, 19, 27, 8, 10, 5, 12, 3.
700 to 800	-	2, 8, 11, 10, 1, 9, 22, 25, 18, 11.
800 to 900	-	10, 16, 9, 10, 7, 11, 5, 3, 2, 0.
900 to 1,000	-	1, 6, 6, 9, 8, 6, 11, 9, 5, 4.

The mean motion of Jupiter is 299″, so that it will be seen that the blanks near 600″, 700″, 745″, 900″ correspond to motions whose ratios to that of Jupiter are $\frac{2}{1}$, $\frac{7}{3}$, $\frac{5}{2}$, $\frac{3}{1}$.

It can scarcely be doubted that the action of Jupiter has in some way produced these blanks. On the other hand, there are two planets whose mean motions are almost exactly 449″, which corresponds to $\frac{3}{8}$ of Jupiter's, so that this ratio does not seem to be an influential one in causing a gap.

It will be seen that the richest regions of the zone are at mean motions 640″ and 775″.

B.A. for March contains some computations on the subject of these gaps by M. O. Backlund. He shows that the mean motions 587″·6 and 607″·0 are critical values, between which the motion of a planet would appear to be unstable, but his researches on this point are not yet concluded.

The interesting planet (434) Hungaria has been observed by Palisa on its return to opposition, its R.A. being 4.3 secs. greater than that given by Berberich's ephemeris in A.N. 3624.

Two new planets have been discovered, both of the 12th magnitude:—FA, by Charlois, at Nice, on February 22; FC, by Schwassmann, at Heidelberg, on March 28. Another very faint planet FD was discovered by Keeler at the Lick Observatory.

FA has a mean motion of 1098″, and so is one of the nearer minor planets. Another planet, provisionally designated FB, proves not to be new, but identical with (117) Lomia.

COMET NOTES.—A considerable number of observations of Giacobini's comet (a 1900) was obtained in the latter half of February, but it was a very faint object of the 13th magnitude, about 2′ in diameter, with a barely perceptible nucleus.

Herr Berberich and Mr. Perrine have deduced the following elements from observations on February 3, 17, 22. (A.N., 3627.) (A.J., 478.)

	Berberich.	Perrine.
$T =$	1900, April 28·9431. Berlin M.T.	April 29·0781 G.M.T.
$\omega =$	24° 21′ 27″ } 1900·0.	24° 36′ 57″ } 1900·0.
$\Omega =$	40 22 31	40 24 39
$i =$	146 27 10	146 25 22
$\log q =$	0·12446.	0·12348.

By the end of March the comet will be too near the sun for observation, but it will reappear about a month later, and remain visible for several months. The following is an ephemeris for Berlin midnight, the brightness being given in terms of that at the date of discovery, January 31:—

Date.	R.A.	N. Dec.	Br.	Date.	R.A.	N. Dec.	Br.
	h m s	° ′			h m s	° ′	
April 27	1 33 12	17 28	0·97	August 1	19 36 18	41 20	1·76
May 29	1 9 0	27 7	1·24	September 2	17 39 12	17 50	0·55
June 30	23 46 54	41 31	1·85	October 4	17 23 12	5 55	0·19

Perrine's R.A. is 3 min. less on August 1.

The comet will be brightest in the middle of July, when its brightness will be just twice that at discovery, but even then it will be a very faint object.

Tempel's second Periodic Comet was followed at the Lick Observatory till December 1 last, when it was a very faint diffused object of the 15th magnitude, with scarcely any condensation. (A.J., 477.)

B.A. for March contains an article by M. G. Fayet on the original orbit of Comet 1892 II.

It will be remembered that Herr Thraen announced a few years ago that the hyperbolic orbit of Comet 1886 II. was due to planetary action, and that the original orbit was elliptic. M. Strömgren, on the other hand, concludes that the original orbit of Comet 1890 II. was hyperbolic. He also points out a flaw in Herr Thraen's researches on Comet 1886 II., viz., that the latter had measured its position from the sun and not from the centre of gravity of the solar system. When a comet is near the sun and moving swiftly this is of little consequence, but when a comet is at a great distance and moving slowly it becomes important, for the speed of the sun round this centre of gravity then becomes comparable with the comet's speed. Thus the question of the original form of the orbit of Comet 1886 II. should be studied anew, Thraen's result being untrustworthy.

M. Fayet has made an investigation on Strömgren's lines on the original orbit of Comet 1892 II. (Denning), which was moving, according to M. Steiner, in the following hyperbolic orbit when near the sun:—

$$T = 1892,\ \text{May } 11{\cdot}26194,\ \text{Berlin M.T.}$$

$$\left.\begin{aligned} \pi &= 22^\circ\,44'\,\ 3'' \\ \Omega &= 253\ \ 24\ \ 10 \\ i &= 89\ \ 41\ \ 54 \end{aligned}\right\} 1890{\cdot}0.$$

$$\log q = 0{\cdot}29468.$$

$$e = 1{\cdot}00035.$$

He finds that the original orbit was elliptical, with $e = 0{\cdot}9984$.

Prof. G. F. W. Rümker, the late Director of the Hamburg Observatory, in succession to his father, its first head, died, after a long illness, on the 3rd of March. He was born there on the 31st of December 1832, little more than two years after his father's return from New South Wales, where he had superintended Sir Thomas Brisbane's Observatory at Paramatta, and where he had detected Encke's comet at its first predicted return in 1822. George Rümker at a very early age began to take part in astronomical observations, as well as in the calculations of planetary and cometary elements and ephemerides; he also assisted in the school of navigation, at that time, as well as the observatory, under the charge of his father. From 1851 to 1853 he was at Berlin under Encke; in the latter year he went to Durham, and for two years was astronomer at the observatory there, succeeding Mr. Ellis, on the removal of the latter to the Royal Observatory, Greenwich. But his father's ill health induced him to return to Hamburgh in 1855; two years later the elder Rümker retired to Lisbon, and the son practically took charge of the operations of the Hamburg Observatory, though he was not definitively appointed its Director until 1867, about five years after his father's death. His energetic labours there are well known; they were not exclusively confined to the observatory,

as he was consulted on various occasions with regard to the school of navigation, and also was for some years responsible for the testing of meteorological instruments used in the German Navy. Owing to ill health he resigned his appointment on the 1st of April last year, being succeeded by Dr. Schorr, and survived his retirement by only about 11 months.

J. J. ÅSTRAND.—The death of this mathematician and astronomer occurred on February 19. He was born on the 22nd of September 1819, at Göteborg, in Sweden, and later on studied at Copenhagen. In 1855 he was appointed to the charge of the School of Marine and the small observatory attached to it at Bergen, in Norway, and also took part occasionally in geodetical observations. He communicated several papers to the "Astronomische Nachrichten," but the work by which he is best known is "Hulfstafeln zur leichten und genauen Auflösung des Kepler'schen Problems."

LEANDER J. MCCORMICK, the founder of the observatory called after him, whose death was recently announced at Chicago, was an inventor of agricultural machinery as well as a patron of astronomy. It was his desire that the observatory and equipment which he presented to the University of Virginia at a cost of 20,000*l*. should be the best of its kind in the world, and at the time of the inauguration such it probably was.

DR. C. T. R. LUTHER, whose death was recently announced, worked for 48 years with the small instruments of the Düsseldorf Observatory. He devoted himself to the discovery and observation of minor planets, and placed the theory of five—Hebe, Parthenope, Melete, Danae, and Glauke—in such a position that they are not likely to be lost. Seven times the Paris Academy voted him the Lalande Prize, and when a medal was struck to commemorate the completion of the first hundred small planets, his portrait appeared on it with those of Hind and Goldschmidt, the representatives of Germany, England, and France. He was a Foreign Associate of the Royal Astronomical Society and a Doctor of Philosophy of the Bonn University.

EMMANUEL LIAIS.—The Paris correspondent of the "Times" announces the death, at the age of 74, of M. Emmanuel Liais, Mayor of Cherbourg. "For many years he held posts at the Paris Observatory, and he was sent in 1857 to S. America to observe the solar eclipse. He organised telegraphic meteorology in France, and devised the use of chronographs in determining longitude by electricity. He also devised a system of automatic magnetic registration by photography, and applied the method of the polarisation of light to the investigation of the solar corona. He bequeaths his property to the municipality of Cherbourg in trust for scientific purposes."

THE NEW ODESSA OBSERVATORY.—From Herr A. Orbinski's first report we learn that this new branch of the Pulkova Observatory consists of a transit house with two buildings for meridian marks or collimators. The transit has an O.G. of 108 mm.

aperture and 1·30 m. focal length by Steinheil, with a self-registering micrometer by Repsold. The meridian marks consist of round plates each pierced with a small hole 1·5 mm. diameter, at distances of 109 m. N. and S. of the pier. An electric light behind the hole forms an artificial star. The same building contains a vertical circle of the same aperture and 1·40 m. focal length. The programme is similar to that at Pulkova, except that the instruments are used alternately, night by night, and not both together. The first list of 176 stars is included in this report. (Nat., March 8.)

Motto for the Association.—The following has been suggested by the Director of the Zodiacal Light Section as an appropriate motto for the Association. The reference to the Observing Sections and to the discussions on the Doubling of the Canals of Mars, the Markings on Venus, and the streaks on the Moon is too evident to need pointing out.

"And no one shall work for money, and no one shall work for fame,
"But each for the joy of the working, and each, in his separate star
"Shall draw the Thing as he sees It, for the God of Things as They Are!" *Kipling*, "*The Seven Seas.*"

Astronomical Publications.

Origin of the Lunar Formations.—I. *W. H. Pickering.*—(From "Harvard Annals," Vol. 32, Part 2.) Prof. Pickering has experimented with paraffin in a pan three inches deep and eight inches in diameter. When the paraffin is melted locally over a small spirit lamp, a hole about a quarter of an inch in diameter is formed in the crust, and this is rapidly enlarged by the rising liquid. When the lamp is extinguished the liquid retires, leaving a smoothly cut pit. Tidal action is imitated by inserting a brass tube fitted with a wooden piston, by working which the liquid is made to rise and fall. If the rod is moved through short distances, ridges and cracks are produced in the floor of the crater; but if air is forced in, explosions result by which cones may be raised, and many terrestrial volcanic phenomena imitated. After the lunar crust first formed it would contract, cracks would be produced which would be enlarged at places into circular holes by the liquid interior, and filled up in the intervening spaces. This process seems to have been arrested in the rill of Hyginus, which is dotted with small craters. When the crust was thin the enlargement of the holes would proceed rapidly, as it thickened the process would be sooner stopped, and we infer that the larger craters like Clavius are older than Tycho or Copernicus, and might be subsequently impinged upon by newer and smaller formations. A reason for the tendency of the older formations to lie in meridional directions is found in the great surface tension produced round the limb by the attraction of

the earth, which was then much nearer. This produced an enormous tide, and as the moon then revolved rapidly on its axis, the surface would be strained and cracked in meridional directions. The subsidences producing the seas occurred at a later period when, owing to interior contraction, the surface was too large instead of too small. The lower seas were probably the last formed. (P.A., March.)

ORIGIN OF THE LUNAR FORMATIONS, II. *W. H. Pickering.*—Lunar craters are divided into six classes grouped in two periods. Those formed before the seas subsided have bright walls, and are classified as unaltered (Copernicus, Tycho); partially submerged (Plato, Ptolemy); softened (Posidonius, Gassendi); submerged. Those formed after the seas had solidified have dark walls, and are classified as dark craters shaped like Copernicus, but smaller (Lambert); craters with smooth floors and deep interiors (Bessel. Horrocks). No true volcanoes are found and it is difficult to see how the necessary explosive force could have been generated unless large quantities of water were present. The rills were cracks formed when the surface was too small for the interior, but the fluid was so far from the surface that little could escape to relieve the pressure. The bright streaks usually issue from minute craterlets, seldom exceeding one second in diameter, and generally much less. They are brilliant near the crater, broadening and growing fainter as they recede to a distance varying from 10 seconds to 50 seconds. Frequently a number of craterlets are arranged in the direction of the streaks which then form a nearly continuous band. The pressure of water vapour at 0° C. is $4 \cdot 6$ m.m., and it is doubtful if that of the moon's atmosphere exceeds $0 \cdot 5$ m.m., so that water cannot exist on the surface; but it is held that the streaks are caused by minute ice crystals carried by winds, produced when the craterlets become active, and blowing away from them; the crystals would settle almost exclusively in the crevices of the rocks, whilst any which fell in more exposed situations would quickly evaporate. When exposed to the sun, as on Aristarchus, they appear bright at sunrise, but otherwise they do not become visible until the sun is well up. Where we see a bright streak, there a few days after sunrise cloud will form, which combines with the absence of shadow to render detail so difficult in these regions at the time of full moon.—(P.A., April.)

THE LUNAR ATMOSPHERE. *W. H. Pickering.*—From "Harvard Annals," Vol. XXXII., Part II.) Observations of an occultation of Jupiter indicate the presence of an absorbing medium to a distance of four miles from the sunlit side of the moon, the medium being absent from the dark side. On 1897, October 13, Alcyone was occulted, and careful observations of the position angle of the line joining it to *p* showed no appreciable change. A variation of $0^\circ \cdot 2$ would certainly have been detected, one of $0^\circ \cdot 1$ might or might not. The pressure of a lunar atmosphere would have half its surface value at 21 miles, or about 17″ from the surface. When Alcyone disappeared, *p* was about 15″ from the limb, and would have been affected by refraction about half as much as Alcyone. The conclusion is that the total

effect of lunar refraction, 2 H, cannot exceed 0″·4 on the bright side of the moon. A list is given of wide pairs, distances from 25″ to 351″, which may be occulted, and are suitable for such observations. When the line joining the stars is nearly parallel to the occulting limb change in position angle should be looked for; when nearly radial the distance should be measured. In either case, the best results may be expected when the occultation takes place near the N. or S. limb, and atmosphere is more likely to be found on the bright side owing to its higher temperature. (P.A., April.)

Search for an Intramercurial Planet. — "Harvard Circular," No. 48, gives a description of the method to be adopted by the Harvard expedition in the State of Alabama. With a 3-in. photographic lens of 11 ft. 4 in. focal length the field will cover nine 8 × 10 in. plates. Four of these instruments will be attached to the same mounting and arranged so as to photograph a region about 32° × 10°, with the sun as centre. Experiment shows that with an exposure of one minute the darkening due to sky light will not obscure the images of stars down to the 8th magnitude.

It is hoped that some observer will be able to duplicate the work in Spain or Algeria. Success at both stations would not only confirm the discovery, but would enable an approximate orbit to be computed, which might be corrected in 1901. (Nat., March 15.)

Planets at their Greatest Brilliancy. *C. T. Whitmell.* —For circular co-planar orbits an interior planet's greatest brilliancy, as seen from an exterior planet, will coincide with its maximum elongation when the radii of the orbits are as $1 : \sqrt{5}$. If the second term is less than this, the interior planet is brightest after elongation, if greater then the maximum brightness occurs before elongation. Thus Venus is brightest after elongation, Mercury usually before, but the eccentricity of its orbit causes irregularities in this respect. (Nat., April 5.)

Periodic Disturbances in the Northern Hemisphere of Jupiter. *A. Stanley Williams.*—In 1880, and again in the years 1891–92, there occurred great outbreaks of spots on the N. temperate belt of Jupiter, these spots being remarkable for their enormous velocity relative to other markings. It has been suggested that these outbreaks recur at intervals of a little more than 10 years, and might accordingly be expected again in 1901. It appears, however, that the evidence in favour of this period is not very strong; and since outbreaks of swiftly moving spots occurred in 1880 and in 1891–92, the true period is likely to be nearer 12 than 10 years, and the next outbreak would not occur before 1903. (Obs., April.)

Photographs of the Zodiacal Light. *A. E. Douglass.*— Defects in visual observations are caused by interference of stellar light, and by liability to mistake ease in distinguishing the zodiacal cone at any point for actual intensity at that point. Difficulties are found in the time required to get perfectly acquainted with

standard reference stars, and the advantage (almost a necessity) of making records in the dark. These led to repeated attempts to obtain photographic records; eventually success was obtained by the use of a positive visual eyepiece of short focus and large aperture. After thoroughly testing the lenses used for ghosts or other concentration of light no doubt remains as to the genuine nature of the results, of which four reproductions are given. The chief conclusions are that the axis is indefinite, and the contour of the apex more rounded than as usually represented; that the Zodiacal Light impresses the plate more readily than equally bright regions of the Milky Way; that the effects of horizon light and atmospheric absorption are very small; that in Leo at about 8° from the ecliptic the intensity fades more rapidly on the southern than on the northern side.—(**P.A.**, April.)

A BRILLIANT FIREBALL.—On March 28, $8^h\ 31^m$, a very large meteor was observed at Bishop's Stortford, at Reading, and by Mr. Crommelin at Blackheath, as well as from other places in the south-east of England. It moved swiftly, probably from a radiant not far from ϵ Ursæ Majoris, and three distinct explosions were observed, followed by a sound like the roar of a distant cannon. Its position was over the E. coast of Kent, and its height at disappearance probably about 52 miles. Many reports are available, and it is hoped that the real path may be satisfactorily determined. (**Nat.**, April 5.)

VARIATION OF LATITUDE AT NEW YORK. CONSTANT OF ABERRATION. *J. K. Rees.*—The latitude of the Columbia University Observatory being nearly the same as that of Naples, the same stars have been used at the two observatories. The observations have been made with a zenith telescope of 80 mm. aperture and 1 m. focal length. Four groups of stars were selected, each of seven pairs. Observations were made every clear night from 1893, May 1, to 1894, July 1, after which it was decided to observe four nights in each half month. Up to December 1899, 6,518 pairs of stars had been measured by three observers on 758 nights. The results are graphically compared with Dr. Chandler's computed curve, and systematic differences are found which Dr. Chandler considers are due to the fact that the annual ellipse is not stationary, the line of apsides retrograding several degrees annually. This revolution is not yet sufficiently demonstrated to be included in the formula, but it is hoped that in another two or three years this may be done. The observations confirm the progressive diminution which the 14 months circular motion has undergone since 1890. They also give determinations of the constant of aberration by Küstner's method, the final value being $20''\cdot464 \pm 0\cdot006$. The value simultaneously obtained at Naples was $20''\cdot533$. That adopted at the Paris Conference of May 1896 was $20''\cdot47$, but as other recent determinations range from $20''\cdot475$ at Strassburg to $20''\cdot580$ by Doolittle, a definitive result cannot yet be stated. (**P.A.**, April.)

ON THE PROBABLE MOTION OF THE ANNULAR NEBULA IN LYRA. *E. E. Barnard.*—From measures made by himself and by Mr. Burnham, Prof. Barnard argues a motion, either in the

nucleus, or in the star, and asks if the central star is a real nucleus or an accidental projection. Everything, he says, points to its being a part of the nucleus, so that if motion is found to exist in the central star it is a motion of the nebula itself. He suggests that the question of motion in the nebula is one singularly suited for the photographic plate to decide, because of the high actinic power of the nucleus. Prof. Barnard points to the fact that planetary nebulæ, owing to peculiarities in their spectra, come to a focus outside the focus of an ordinary star, and shows that the planetary nebulæ so far observed give a focus for the nebula itself about 0·19 inch further out than its nucleus, and about 0·25 inch farther out than for a fixed star. (**M.N.**, January 1900, (*continued*).)

THE EXTERIOR NEBULOSITIES OF THE PLEIADES. *E. E. Barnard.*—Prof. Barnard states that from many years comet-seeking he has known of a vast and extensive, but very diffused, nebulosity north of the Pleiades. He gives a drawing from different photographs, and shows that a study of these photographs has brought out the fact that the Pleiades, and their involved nebulosity are but the central condensation of an enormous nebula, intricate in details, and covering at least a hundred square degrees of the sky. (**M. N.**, 1900 (*continued*).)

THE RUTHERFURD PHOTOGRAPHS. *Flora E. Harpham.*—Just as photography became serviceable, Mr. Rutherfurd was able to give up law practice and devote his whole energy to scientific pursuits. He devised a ruling engine for interference gratings, surpassed only by Prof. Rowland's, he constructed a photographic telescope with an 11-inch object glass, followed by one of 13 inches, and made the first measuring micrometer for stellar photographs. The essential parts of the instrument, which differs very little from the modern Repsold, are a microscope micrometer, a graduated circle and a graduated scale. It can be used to give directly, either rectangular co-ordinates, or distance and position angle, though Mr. Ruthurfurd always preferred the latter. To obtain a fiducial direction the plate was first exposed long enough to obtain an impression, then covered whilst the telescope was moved to the west, so that a second exposure gave another impression east of the first, the stars were then allowed to trail across the first image, and as they approached the edge of the plate the clock was again connected, and a third and short exposure given. In the year 1890 he gave to Columbia University nearly 1,500 of his finest negatives with his telescope, micrometer and observatory equipment, and the volumes containing the measures so far made. Most of these were unreduced, but in 1865 Dr. Gould had discussed his measures of the Pleiades, and subsequent measures by Dr. Jacoby, made 20 years after the plates were taken, have shown no deterioration. (**P.A.**, March.)

THE CAPE STAR CATALOGUE FOR 1900 contains the positions of 3,007 stars from observations at the Royal Observatory during the years 1885–95, reduced to the mean equinox 1890·0 without proper motion. The declinations are corrected for flexure, refraction, and change of latitude. No systematic error in declination

is traceable to magnitude, but it is found that the average observer records the transits of faint stars too late as compared with bright ones. In future catalogues this personal error should be determined for all the observers. Three appendices give comparisons with other catalogues; special observations of α Canis Majoris, α Canis Minoris, β Centauri and α_1, α_2 Centauri, which all have companions of considerable mass; and a discussion of the places and proper motions of twenty-four circumpolar stars used at the Cape for determinations of azimuth.—(Nat., April 19).

THE DEVELOPMENT OF ASTRONOMY IN AMERICA.—Sixty years ago the United States had scarcely one properly equipped observatory; now they have the finest in the world, manned by the most competent and untiring observers. After giving a short account of some of the advances made in America in all departments of astronomy since Bond's discovery of Hyperion in 1848, the writer contrasts the attention given to the training of astronomers in America with that found in England. In the "Report of the Commissioner of Education, 1897–98," Prof. Holden gives particulars of the instruction offered at 15 institutions. That of the University of Chicago is the most complete, and includes all branches of theoretical and practical astronomy, astro-physical instruction being given at the Yerkes Observatory. Students of promise are also received at the Lick Observatory, at those of Harvard College, and of the Universities of Yale, Michigan, Virginia, Wisconsin, and Pennsylvania. In Great Britain there is only one institution at which any attempt is made to give practical instruction in astronomical physics, and, even then, the greater part is necessarily of an elementary character. Vacancies in our observatories have to be filled by observers who have still to make practical acquaintance with the work expected of them. (Nat., April 12.)

Variable Stars.

Maxima and Minima of Long Period Variables, (P.A., 156.)

MAXIMA.—APRIL.

Star.	Mag.	Day.	Star.	Mag.	Day.
S Piscium	8·6	29	*RR Scorpii*	7·3	5
S Camelopardalis	8·4	16	*RS Herculis*	8·0	2
U Orionis	7·0	17	*R Cygni*	7·0	1
U Canis Minoris	8·7	30	*X Aquilæ*	8·6	16
S Pyxidis	8·3	3	*Z Cygni*	7·8	2
W Cancri	9·6	13	*R Microscopii*	8·0	1
X Hydræ	8·4	30	*W Aquarii*	8·0	6
— *Virginis* (1)	8	6	*V Aquarii*	8·1	10
R Canum Venat,	6·4	2	*T Aquarii*	7·2	20
R Trianguli Australis.	6·7	5	*R Vulpeculæ*	8·0	1
			— *Pegasi* (2)	9	9
X Libræ	9·7	9	*SS Cygni*	8·5	14?
V Coronæ	7·4	12	*U Aquarii*	9·7	25
X Scorpii	10·0	10	*R Cassiopeiæ*	6·0	27
S Scorpii	9·7	23			

MINIMA.—APRIL.

U Cassiopeiæ	<15	11	*U Bootis*	12·8	2
T Arietis	9·5	28	*R Serpentis*	13	6
o Ceti	9	10	*S Herculis*	12	4
V Orionis	<13	6	*R Aquilæ*	11·2	4
R Lyncis	<13	29	*T Sagittæ*	9·6	27
T Cancri	9·9	20	*V Cygni*	13·5	20
Y Virginis	12·2	30	*RR Cygni*	9·5	29

(1) R.A., $12^h\ 39^m\ 54^s$, + 4° 56′·1 (1855).
(2) „ $21^h\ 14^m\ 8^s$, + 13° 50′·3 (1855).

Minima of the Variable Stars of the Algol Type.
(Given to the nearest hour G.M.T.)
(P.A., 157.)

U Cephei.

	d	h
Apr.	4	16
„	9	14
„	14	14
„	19	14
„	24	13
„	29	13

Algol.

	d	h
Apr.	17	13
„	23	7

R Canis Majoris.
Every 8th Min.
$P = 1^d\ 3^h·3$.

	d	h
Apr.	1	14
„	10	16
„	19	18
„	28	20

S Cancri.

	d	h
Apr.	3	17
„	22	16

S Velorum.

	d	h
Apr.	23	22
„	29	20

δ Libræ.

	d	h
Apr.	1	14
„	2	22
„	8	14
„	10	21
„	15	13
„	17	21
„	22	13
„	24	21
„	29	12

U Coronæ.

	d	h
Apr.	1	12
„	4	23
„	8	10
„	11	21
„	15	8
„	18	18
„	25	16

U Ophiuchi.
Every 10th Min.
$P = 20·1^h$

	d	h
Apr.	4	21
„	13	6
„	21	16
„	30	1

RS Sagittarii.

	d	h
Apr.	4	11
„	6	21
„	11	17
„	16	13
„	18	23
„	23	19
„	28	15

DM + 45° 3062.

	d	h
Apr.	1	17
„	6	7
„	10	20
„	15	10
„	20	0
„	24	14
„	29	3

DM + 12° 3557.

	d	h
Apr.	1	16
„	2	14
„	3	11
„	7	22
„	8	19
„	9	16
„	10	14
„	11	11
„	15	22
„	16	19
„	17	16
„	18	14
„	19	11
„	23	22
„	24	19
„	25	17
„	26	14
„	27	11

W Delphini.

	d	h
Apr.	11	20
„	16	16

SS Cygni.—The rise occurred between December 31 and January 2, the maximum about January 7 at $8·4^m$, and normal light was reached about January 19, giving a typical long maximum (**P.A.**, 158).

SU Cygni.—Since August 11, 71 observations have been obtained; period $3^d\ 20^h\ 15^m\ 21^s$, varying from $6·57^m$ to $7·37^m$ (**Kn.**, 65).

U Geminorum.—The maximum was passed about January 2 (**P.A.**, 158).

S Virginis.—The actual date of maximum, $6·80^m$, was July 22, 23, whereas the computed date was June 26 (**Kn.** 65).

D

VARIABLE STARS OF THE ALGOL TYPE. *H. C. Wilson.*—This contains an explanation of the way in which the variation is produced by two stars revolving round their centre of gravity and alternately eclipsing one another, and some computations showing how the dimensions of the orbits, the radii, masses, and densities of the stars may be deduced. The orbit of Algol is found to be very nearly circular and the stars of very unequal brightness, but by supposing the stars to be surrounded by atmospheres having an absorption of one-fortieth of the earth's atmosphere, and the orbit to have an eccentricity of ·011, Wilsing has computed a light curve which nowhere differs from the observed curve by more than ·02 mag. In some stars of this type there is a small check in the recovery of light after minimum which is very difficult of explanation, and seems almost fatal to the satellite theory. It is well seen in U Ophiuchi. Remarkable results are obtained for S Velorum, in which the fainter star is the larger, totally eclipsing the brighter for 6½ hours, but its density cannot exceed one-thirtieth that of the sun. (**P.A.**, March.)

REFRACTIVE INDEX OF ROCK-SALT.—*Prof. S. P. Langley*, in his report of the Smithsonian Institution for the year ending 1899, June 30, describes experiments on rock-salt prisms from which it appears that specimens from Bavaria have the same refractive index as those from Russia. It follows that his measures made in 1897–98, fixing the positions of 700 lines in the infra-red rock-salt spectrum give absolute determinations, and as the average probable error was only three parts in 10,000, the accuracy is comparable with that of measures on the visual spectrum. (**Nat.**, April 5.)

ASTRONOMY WITHOUT A TELESCOPE III. THE NORTHERN STARS. *E. Walter Maunder.*—The circumpolar stars which form in these latitudes a great dial plate marking both the progress of the night and of the year, are fully described in this paper. (**Kn.**, April, 1900.)

THE ECLIPSE WIND. *A. L. Rotch.*—It is still uncertain whether those changes do occur which should result from the chilling of the air in the moon's shadow and the increased barometric pressure out of which the wind should blow in all directions. Observation seems to prove the change in pressure to be so small as to escape measurement, but there does appear to be evidence of changes in the wind, though the reports are contradictory. It is hoped that on May 28 observers will make frequent observations of the direction and strength of the wind. Still more valuable data could be obtained from a few self-recording wind vanes and anemometers exposed high enough above the ground to be free from local influences. (**Nat.**, April 19.)

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REPORT OF THE MEETING OF THE ASSOCIATION, HELD ON APRIL 25, 1900, AT SION COLLEGE, VICTORIA EMBANKMENT.

W. H. MAW, F.R.A.S., *President*, in the Chair.

J. G. PETRIE, F.R.A.S.
A. C. D. CROMMELIN, F.R.A.S. } *Secretaries.*

The *Secretary* read the Minutes of the last Ordinary Meeting, which were confirmed.

The names of five candidates for admission were read and passed for suspension, and the election by the Council of seven new Members was confirmed.

The *President* said that Mr. Maunder, Miss Bacon, and Mr. Crommelin had kindly promised to give some account of the work which they proposed to do on the occasion of the forthcoming total eclipse of the sun.

Mr. Maunder said the programme which his wife and himself proposed to try to fulfil was simply a slight extension of that which they carried out in India in 1898. They had then one small lens of 1½ in. aperture and 9 in. focal length, and they made a number of exposures of varying length. Their longest exposure was 20 sec., and the pair of photographs to which they gave that exposure succeeded in bringing up the extensions of the corona much further than they had ever been taken before. In the coming eclipse they wanted to give the whole of totality as nearly as might be to each photograph, and in order to get a duplicate they had a second lens exactly like the one they used in India. They would use, therefore, a twin camera with two lenses, each 1½ in. aperture and 9 in. focal length, and make one exposure during the whole of totality. Then, with the idea of getting the extensions, if possible, on a larger scale, they had a pair of rapid rectilinear lenses of 18 in. focus, which worked also to the same aperture (1½ in.), and those they would also expose for nearly the

whole time. If, therefore, they were fortunate, they ought to get four photographs giving a considerable extension to the corona. They would also try to photograph the corona after the end of totality with those instruments. They had a 4 in. telescope of rather short focal length, with which they hoped, if possible, to get a half-a-dozen photographs of the inner corona. That would probably keep them sufficiently busy during the minute of totality they would have at Algiers; but if possible they would also try one or two other experiments.

Miss Bacon said the American expedition under her father's leadership, of which she also was a member, proposed to leave England on May 10, sailing for New York by the Atlantic Transport's new boat *Minneapolis*, of 16,000 tons. Upon arriving in New York the party would at once proceed to their camping ground, Wadesborough, North Carolina. Wadesborough was distant about 22 hours by rail from New York on the main line of the Pennsylvania Railroad, which had kindly promised the expedition special concessions for the occasion. The Naval Department had granted that their instruments should be admited into the country free of charge and examination. The Canadian Government had granted similar facilities should they pass into Canada, and the English Government had done the same for their return to England; so that they ought in that way to be saved the inconvenience and possible risk to photographic material which there might otherwise be at the hands of too officious officials. They hoped to be at Wadesborough, with a week to spare before the eclipse, to allow of their making all necessary preparations. They were exceedingly fortunate in that Prof. Young, the eminent solar authority, with his party from the Princeton Observatory, had chosen the same station. They had already received a most courteous letter from Prof. Young, giving them permission to share his camping ground, and offering them every assistance in his power. Such invaluable assistance would, of course, be very much appreciated by them. The kindness of the American astronomers generally had been very great, especially of the eclipse committee of the Yerkes Observatory, who had even sent them the name and address of a prominent citizen of Wadesborough, with whom they had been able to arrange for the accommodation of the expedition. After the eclipse, the party would travel to Chicago, where they hoped to take advantage of the kindness of Prof. Barnard, who had given them an invitation to visit the Yerkes Observatory. After that they would doubtless split up into various excursions through the country, re-uniting at Montreal on June 16 and sailing for England, which they hoped to reach in time for the June meeting. As to the work, the party would consist of four ladies and four gentlemen. Mr. Nevil Maskelyne, F.R.A.S., assisted by Mrs. Maskelyne, would (1) direct the telescopic kinematograph upon the corona throughout totality, and (2) expose a long film in an ordinary kinematograph camera directed towards a chosen point of the landscape for a period commencing somewhat before, and terminating somewhat after, totality. Her father, the Rev. J. M. Bacon, F.R.A.S., with a telescopic camera, 4·1-in. aperture and 60-in.

focal length, would photograph the inner corona as at Buxar, India, the exposures however being shorter, and the development more prolonged. He would endeavour to make these exposures at definite and exact moments, symmetrical with reference to mid-totality, to aid in determing the relative position of sun and moon. He would also expose to the zenith for several minutes before, during, and after totality, a long sensitive film continuously driven in a specially designed automatic instrument. By means of a kite he would compare during the eclipse the temperature at an altitude of a few hundred feet with that on the ground. Mr. G. Dixon would photograph the corona with a telephoto. camera or a 3-in. Dollond, or possibly with both. She (the speaker) would endeavour to photograph the outer corona and extensions, using a clock-driven battery of four box cameras with sliding arrangements for changing plates, and fitted with different Dallmeyer and other lenses in which $\frac{a}{f}$ is approximately $\frac{1}{6}$. She would also repeat her former experiment of taking a "gathering gloom" series. Miss Dixon would devote her entire attention to making observations with the same slitless spectroscope, kindly lent by Miss Page, which she used at Buxar. Their irreparable loss in the enforced absence of Mr. Simpson must, as far as possible, be redeemed by the services of a friend in New York, who was anxious to join their camp. Special observations of shadow bands would be organised, these including a proposal by a party of cyclists to pursue them along a white road. Photographic tests would be adopted, as at Buxar, to compare the light of the corona with that of the full moon. Folded cards of suggested questions, together with squares of dark glass, would be given to outsiders able and willing to undertake useful work.

Mr. Crommelin showed a set of 20 slides illustrative of Algiers and its environs. He and his wife, he said, were going with Mr. Maunder's party. They hoped to arrive in Algiers six days before the eclipse, and would stay at the Hotel de la Regence, which was in the centre of the town, close to the harbour. At the hotel there was a large flat roof, from which they would be allowed to observe, and this would be a great convenience. Their programme was a very short one. They had a Dallmeyer telephoto. lens, lent by Mr. Cavan, the aperture being $1\frac{1}{2}$ in., and the focal length adjustable. They would make it about 80 in., which would make the sun's diameter about $\frac{8}{10}$ in. This would be fixed, and they would only give a short exposure, as short as it could be made by hand—say, $\frac{3}{4}$ sec.—with Cadett lightning plates, and, from experiments they had made, they hoped to get the inner corona successfully with the exposure. He had also a small lantern lens, about 10 in. focus, with which he would try to get another photo. He would also take a Dollond 3 in., with which he hoped to have a look at a small portion of the corona, and try to make a sketch, as Mr. Wesley suggested, of the connection between the prominences and the streamers of the corona. It had been said by observers that there was a good deal more detail to be seen on the inner corona than any of the photos. showed, and he had recommended that drawings be made of the detail of

some portions of the inner corona. He also hoped to have an instantaneous shot at the disappearing shadow in the sky after totality. This had often been seen, but, he believed, never photographed. They hoped while in Algiers to be able to do a good deal of sight-seeing as well as astronomical work. There were great facilities for getting about in the way of omnibuses and tramcars, and, having their instruments in the hotel at which they would be staying, they would be able to adjust them quickly. A Fellow of the Meteorological Society, who had spent 13 years in Algiers, had informed him that the heat there at the end of May would probably not be worse than that often experienced in August in this country. There might be a midday temperature of 90°, but the nights were cool. The only thing they need fear was the Sirocco—the heat wind from the Sahara—which was not only uncomfortably warm, but filled the air with grey dust, which would be adverse to observations of the corona. He hoped, however, they would not have that experience at the time of the eclipse.

Mr. G. F. Chambers remarked that probably all present had seen a notice in the newspapers emanating from the Foreign Office as to various facilities which were going to be afforded to British observers visiting Portugal. The Association had received a copy of a circular which had been issued by the director of the Lisbon Observatory, and which contained one or two important pieces of information which were not given in the Foreign Office letter. The railway companies in Portugal were going to grant tickets to duly authenticated astronomers at half-price, but astronomers travelling on the State railways from Oporto to Valença, and also by the narrow-gauge railway to Vizeu, would be carried free. In order to obtain these concessions those who desired them must communicate with the Royal Observatory at Lisbon, and instructions would then be given to the directors of the railways to issue the necessary tickets. There was reason to suppose that the climate of the region to be visited was generally agreeable and healthy during May. There were good hotels at Oporto and Luso; passable ones at Aveiro, Vizeu, and Guarda. Every astronomer desiring to take advantage of these travelling facilities, and especially those who desire to avoid difficulties at the Portuguese Custom House, must go prepared with a certificate saying who they were—namely, Eclipse tourists. No particular form of certificate was prescribed; but he had sketched one out which the President thought would meet the case. With regard to the members going, he (the speaker) went two days ago to the office of the Royal Mail Co., who told him that their offer to take a party from the Association by the steamer on May 11 and land them at Oporto must be considered to have lapsed, because the minimum number required—viz., 20, had not been forthcoming. Therefore, what they proposed to do was to leave Southampton on Friday, May 11, and be landed at Lisbon. They would stay there two days, and then work their way quietly up to Oporto, viewing the scenery and architecture on the way up. They proposed to return by the corresponding steamer, which would pick them up at Vigo on Wednesday, May 30. It was very

doubtful whether there would be time to get back from Oporto or any of the stations towards Lisbon, so as to rejoin the steamer at Lisbon. Therefore it was practically certain that they would have to go the other way and rejoin the steamer at Vigo. That was not to be regretted, because it involved a saving of about 1*l.* 10*s.* in the steamer return ticket, and they would have the opportunity of seeing the north-western corner of Spain, which was exceedingly picturesque and interesting all the way round from Valencia, on the Portuguese frontier, to Vigo. The only objection to this was that Spain was Spain, and it was not a very pleasant country in which to travel. There were various customs, restrictions, and conditions of a Spanish character with which Britishers were not very familiar, happily. However, these must be faced and got over: they must pay something for the privilege of going that way.

The *President*, referring to the announcement Mr. Chambers had just made, said that until it was known how many of the members were going to Portugal, they could not tell whether it would be worth while to have a printed form of certificate. It was hoped that any member who intended going would at once communicate with the Secretary, sending him a list of instruments and other articles which he wished to take with him, and a certificate would be forwarded to him with the least possible delay. At the present, the Spanish and French Governments had made no formal announcements whatever as to their intention with regard to Customs facilities. It was hoped such announcement would be made in the course of the next week or so, and in such case similar certificates to those already referred to would be prepared. Any communication which members going to stay in Portugal, Spain, or Algiers might make to the Secretary would receive immediate attention at headquarters, and the officials of the Association would do everything they could to facilitate members getting all the benefits which the various governments might offer. It was desirable, in the case of the Portuguese certificate, that it should be viséd by the Portuguese Consul here, and a corresponding course might also be necessary in the case of any other certificates that might be issued to members visiting Spain or Algeria.

The *President* asked Mr. Maunder whether Prof. Hale was likely to have any spectro-heliographs taken of the sun from a point where it was not eclipsed.

Mr. Maunder replied that he had not heard definitely that that was the case; but he believed that both at Lick and Yerkes they had this object well in view—the spectrographic record of prominences, and also the searching for chromospheric lines. *Mr. Maunder* added that the Eclipse suggestions which appeared in No. 4 of the "Journal" had been reprinted in separate form, and copies could be obtained on application to the Assistant Secretary. He wished to specially draw the attention of those who intended to observe shadow bands to the questions Mr. E. W. Johnson had drawn up under that head. If shadow-band observations were undertaken, it was extremely desirable that they should be

carried out, as far as possible, under one system. Mr. Johnson would gladly receive, collate, and discuss all shadow-band observations after the Eclipse.

Two slides were then thrown upon the screen, showing the sun as photographed by monochromatic light (K line) by means of the spectro-heliograph.

The *President* remarked that it would be very interesting if a photograph of a similar character could be taken at stations outside the shadow track during the coming Eclipse.

Mr Thwaites suggested that those who proposed to draw the corona should arrange previously what portion they would sketch, so that there might be no duplication of work, and that he sketching of the whole corona might be insured.

The *President* said this was a very valuable suggestion, and it would be a very good thing if, for instance, anyone proposing to go to Algiers, would communicate with Mr. Maunder, signifying their wish to be apportioned a section of the corona, leaving Mr. Maunder to divide it out as he thought best. Mr. Bacon's party would probably arrange a division among themselves.

Mr. Maunder said that in India a quadrant was found to be about as much as could be taken by any observer who was observing without a telescope; but an observer with the telescope should, he thought, confine himself to a still smaller section.

Mr. Keatley Moore, who showed a slide illustrative of the combined efforts of four artists to sketch the corona, said he would be happy to receive the names of those who proposed to sketch the corona, and would allot them quadrants so that all might not afterwards been found to have sketched one portion.

Mr. Evershed said that his work in Algiers would be to photograph what was known as the flash spectrum—that is, the spectrum of a very thin gaseous layer lying immediately over the photosphere. It was called the flash spectrum because on the central line it only lasted visible about a second at second contact, and another second at third contact. He proposed to get on to the edge of the shadow, where it would last a great deal longer. To an observer on the central line the moon's motion was in a direction at right angles to the layer, and it was therefore quickly occulted immediately after second contact. But near the edge of the shadow track the moon slid across at a much smaller angle, and took much longer to occult it; in fact, the spectrum could be photographed practically during the whole of totality, only the very lowest layers being occulted at mid-eclipse. He had chosen a station so near the edge that at mid-totality he would be only two miles from sunlight. The principal instrument he proposed take for the work was an ordinary reflecting telescope, modified for the Eclipse, and converted into a reflecting prismatic camera. He believed that a reflector had not previously been used at Eclipses, but he hoped to get good results with it. It had great advantages in some respects. In the first place, the focus was the same for all parts of the spectrum, and therefore, if carefully

focussed, say, by the F line, which was easily visible, it was in focus for the rest of the spectrum. Another thing was that the aperture admitting light to the prism was close by the side of the plates. He had a rack-and-pinion arrangement for racking the plates across the image so that he could take a succession of photographs, and the aperture for making the exposure, was close by the side of it, so that he could make the exposure with one hand and rack the plates along with the other. He hoped to get about 20 images of the flash spectrum during the total phase. Dr. Downing told him he had about 29½ sec., and he (the speaker) thought he could extend that to about 35 sec., because he could photograph just before and just after totality. With regard to the corona, he could make no observations at his station because the duration of totality was so short; but he would like to call the attention of those who were going on the central line to the importance of observing the detailed structure of the inner corona in relation to the prominences. Those who observed prominences in the spectroscope were familiar with the very complicated structure which they always showed under good conditions of seeing; and it had always struck him how closely many of the prominence types of structure were reproduced in the larger coronal forms. It would be exceedingly interesting to make a careful drawing of the coronal forms and details of structure immediately over a large prominence. He would be very glad to assist in this work by preparing a chart showing all the larger prominences visible in the spectroscope on the morning of May 28, and sending this in by messenger to Algiers for the use of intending observers, who could then select beforehand the particular prominence they intended to study during totality.

A paper by Prof. Turner was read in reply to the Rev. C. D. P. Davies' inquiries on the Cœlostat.

Mr. Holmes read a paper on "The Canals of Mars."

A paper by *M. Antoniadi* on "Considerations on the Double Canals of Mars" was also read.

Mr. Maunder said he should be very sorry if his use of the word "miraculous" with reference to Mr. Stanley Williams's observations were taken as being used in any disparaging sense. He simply wished to refer to Mr. Williams's remarkable keenness of sight and acuteness of observation. Mr. Holmes had made reference to some observations of his (the speaker's) on the limit of visibility of small objects. He (the speaker) was referring in those observations to dark markings seen on a bright ground. With regard to the comparison of discordant drawings, it seemed to him that there were two errors which they should be careful to avoid. If they had a large number of drawings of a given object, they would undoubtedly find that they differed in a great many details, and yet by carefully comparing them he had no doubt they could get at a very approximate idea of what was really before the different observers at the time that they made their observations. They would not be justified in rejecting them on account of these differences; but, on the other hand, they most certainly could not assume that if two drawings differed, the object had therefore

changed in the meantime, because if they took any single observer of the planet Mars, and went through his drawings, taking the trouble to compute the Martian longitudes and latitudes for the different markings, they would see that even our best artists would misplace a very definite marking on the planet by a considerable amount. So far as he had gone through the drawings of Mars, he thought those of Mr. Green were the most faithful in that respect. He had noted some of Schiaparelli's as open to criticism on that point, and this might be said of a good many other observers also. On the other hand, in 1892 he had two drawings sent in, one by Mr. Stanley Williams and the other by Miss Everett, which were taken within a very few minutes of each other, and a tracing from one drawing fitted almost exactly over the other in every respect. It was thus clear that in drawings made by competent artists they really had evidence of very considerable value. The only question was as to how they were to determine when they found a little discrepancy between them. He thought they must proceed in just the same manner as they did in regard to numerical observations, say, in the micrometric measures of a double star, or the diameter of a planet. They did not assume that if two measures differed a little the planet had altered in its diameter between the making of the two observations; nor did they reject the observations; but they took the mean of a large number of observations, and assumed that as being the most probable value which the observations gave. If he remembered rightly, M. Antoniadi had concluded that the Kaiser Sea showed a progressive variation in its western border in a series of years by an amount that was much less than the average error of delineation of most observers. It was, nevertheless, possible that this conclusion was well founded if M. Antoniadi had a sufficient number of observations at his disposal for each of the years concerned.

Capt. Noble remarked that these attempts to reconcile most singularly discordant observations reminded him of a tale he once heard. A clergyman saw two men fighting in the street, and said: "Come, you must not fight, my good men." "But," said one of them, "he has called me a liar." Said the other fellow, "He said I was a lazy, idle lout." "Well," said the clergyman, "why should you quarrel about a mere difference of opinion. The chances are you are both right." (Laughter.) Capt. Noble went on to say that at one time he took a great interest in Mars, and made a very large number of drawings, some of which Mr. Green used in his series in the *Memoirs* of the R.A.S. Mr. Holmes spoke in his paper of their being no atmosphere on Mars. He had himself seen the whole of the detail on the eastern limb of Mars—he would not say so sharply as Schiaparelli drew it; because he always seemed to adorn it with hard black lines like the poker-work the ladies do—but he had seen it perfectly sharp up to the limb, while the opposite limb had been so covered with haze that all detail had been lost. This gave him the impression that the Martian sunset must be hazy and the sunrise very clear. Whether that was so or not he did not know.

Mr. Maunder wished to be allowed to give a further and more familiar illustration on the point as to which he had spoken. When he was the Director of the Mars Section in 1892, he measured the Polar Cap as given by all the drawings sent in. The discrepancy between the figures given as the size of the Cap by the different observers might be taken as showing that no reliance could be placed upon them at all—one observer giving its diameter as three times as great as another did—and yet by following any particular observer through the Opposition, very clear evidence was obtained of even a delicate progressive diminution in the Polar Cap as the Martian season went on. So that the very same drawings, which showed great discrepancies between themselves, also afforded clear evidence of a minute progressive change. The same sort of thing occurred, though less clearly, in respect to various other markings on the planet.

Mr. Thwaites expressed the opinion that with regard to the visibility of very small objects it was largely a question of illumination, and instanced the distances to which spider-threads could be seen on a frosty morning.

Mr. Tappenden remarked that it was always assumed that there was a large quantity of water on the planet Mars, but he had never been able to understand why there should be any water. The planet was considerably further from the Sun than the Earth was, and the atmosphere was not nearly so thick, and yet our atmosphere was very few degrees above the freezing-point of water.

Mr. Whitmell did not think there was a large body of deep water on Mars. If there were, as was pointed out by Mr. Taylor in a paper which he read before the R.A.S. some time ago, an image of the sun would certainly be formed, and no such image had ever been seen. At the same time he did not think there was any difficulty in supposing that water existed as water on Mars.

Mr. Crommelin asked Capt. Noble whether, at the time he made the drawing to which he had referred, the planet was fully illuminated, and Capt. Noble replied that it was—it was at the time of Opposition.

Capt. Noble said that Dr. Johnstone Stoney, arguing from the kinetic theory of gas, which he (the speaker) presumed no one would contest, contended that from the small mass of Mars hydrogen would fly off into space—Mars would not have the mass to retain it. Dr. Stoney thought that what was taken for polar snow was really frozen carbon dioxide, and not snow or water at all.

Mr. Whitmell gave a *résumé* of a paper he had written on "The Greatest Brilliancy of an Inferior Planet."

Mr. Crommelin said that with reference to what Mr. Whitmell had said as to the favourable position of Mercury at the time of the total eclipse, some of the members might have seen a suggestion by Prof. Möller that this would be a very favourable opportunity

for getting the albedo of Mercury. Practically, the only time when they could see Mercury fully illuminated was when the Sun was totally eclipsed and when Mercury was at the same time in superior conjunction. Prof. Möller was going to make observations in Portugal, and would compare with his photometer the brilliancy of Mercury and Venus during totality. This was an observation that could only be made by an observer practised in that line. Prof. Möller appealed to some other observers to make a similar observation, in order to corroborate his results. It would be of no use for anyone to take it up who was not accustomed to photometric observations, because it would have to be made very rapidly, and such an observer might get a very erroneous result.

The Meeting adjourned at 7 p.m.

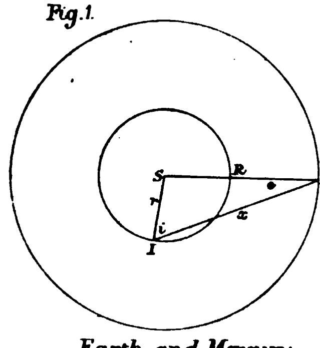
Papers communicated to the Association.

The Greatest Brilliancy of an Interior Planet.

By C. T. WHITMELL, M.A., F.R.A.S.

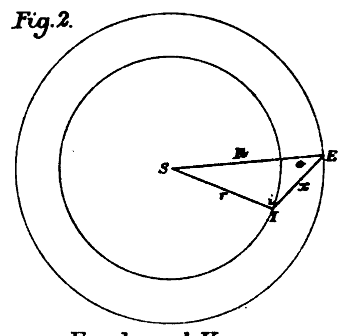
Let there be two planets supposed to move in circular coplanar orbits, with the sun in the centre. Put S for the sun. Call the exterior planet E, its radius vector R, the interior planet I, and its radius vector r. Let x be the variable distance between E and I,

Fig. 1.



Earth and Mercury.

Fig. 2.



Earth and Venus.

e the variable angle of elongation of I from S as seen from E, and i the variable angle between E and S as seen from I, the phase-angle as it is sometimes called. (*See* Figs. 1 and 2, which are not drawn accurately to scale.)

Represent the brilliancy of I, as seen from E, by the symbol L, then L is proportional to $\frac{1 + \cos i}{2r^2x^2}$, that is to $\frac{1 + \cos i}{2x^2}$, as r is assumed constant. Here $\frac{1 + \cos i}{2}$ stands for the ratio of the illuminated part of the disk to the entire disk considered as a

circle, or, what is the same thing, for the ratio of the illuminated part of the diameter to the whole diameter.

For maximum elongation, $x = \sqrt{(R^2 - r^2)}$, and then $\cos e = \frac{\sqrt{(R^2 - r^2)}}{R}$; $i = 90°$, and exactly half the disk is illuminated.

Now it was long ago shown by Halley that L is a maximum, when

$$x = \sqrt{(3R^2 + r^2)} - 2r \text{ - - - - - - } (1)$$

and that, when x has this value,

$$\tan e = \frac{1}{2} \tan \frac{i}{2}$$

$$\text{and } \cos e = \frac{2}{3R}\left[\sqrt{(3R^2 + r^2)} - r\right] \text{ - - - - - - } (2).$$

As a rule, for one value of e in (2), there are two possible values of x, but (1) will determine which value is to be taken.

The largest and smallest values of x are $R + r$ and $R - r$, and it is obvious that, when $x = R - r$, the brilliancy of I for E is zero; for I is then in inferior conjunction with the sun, and has its dark side towards E. This holds, whatever be the ratio between r and R, provided r is less than R. Thus L has its absolute minimum, zero, when $x = R - r$.

Now consider various ratios between r and R, and their relation to the position of the interior planet when at its greatest brilliancy.

I. Let $r < 0 \cdot 25$ R.

Equation (1) gives a value of $x > R + r$, a result corresponding to an impossible condition, whilst equation (2) yields an imaginary value of $\cos e$. It will, however, be found on trial that, if $r < \cdot 25$ R, L has its greatest value when $x = R + r$, *i.e.*, when I is in superior conjunction with the sun, and therefore invisible. The elongation e is zero, i also is zero. Thus, L is zero at inferior conjunction, and has a maximum at superior conjunction when the whole disk of I will be illuminated.

II. Let $r = 0 \cdot 25$ R.

Then, by (1) and (2), $x = R + r$, $e = 0°$, $i = 0°$, and, as in (I), L is at a maximum at superior conjunction, and the whole disk is then lit up.

III. Let $r > 0 \cdot 25$ R, but $< \frac{R}{\sqrt{5}}, < 0 \cdot 447$ R.

Then $x < R + r$, but $> \sqrt{(R^2 - r^2)}$, which is the value of x for maximum elongation. The angle e will be $> 0°$ and $< 26° \, 33' \, 54''$, and $i < 90°$. L has a minimum at superior conjunction, and two equal maxima at two equal elongations (less than maximum elongation), and corresponding to two equal distances greater than maximum elongation distance. The first maximum of L occurs before maximum eastern elongation, and the second after maximum western. More than half the disk is illuminated. *See* Fig. 1, Earth and Mercury.

IV. Let $r = \frac{R}{\sqrt{5}} = 0\cdot447$ R.

Then, $x = \sqrt{(R^2 - r^2)} = 2r$, $e = 26° 33' 54''$, and $i = 90°$.

In this case, L has a minimum at superior conjunction, and two equal maxima at elongations and distances corresponding to maximum elongation E. and W. Just half the disk is lighted.

V. Let $r > 0\cdot447$ R, but $<$ R.

The $x < \sqrt{(R^2 - r^2)}$, but $> R - r$.

Angle $e > 26° 33' 54''$, but $< 48° 11' 23''$, and $i > 90°$. Thus L has a minimum at superior conjunction, and two equal maxima at two equal elongations (less than maximum elongation) and corresponding to two equal distances less than maximum elongation distance. The first maximum of L occurs after maximum eastern elongation, and the second before maximum western. Less than half the disk is illuminated. *See* Fig. 2, Earth and Venus.

VI. Let $r = R$.

Then, in the limit, $x = 0$, $e = 48° 11' 23''$, and $i = 131° 48' 37''$. This means that, the more nearly r approaches to R in value, the smaller does x become, and the more nearly do e and i approximate to the values given above. L has a minimum at superior conjunction, and has two equal maxima, the positions of which ultimately coincide at inferior conjunction. In the limit, just $\frac{1}{6}$th of the disk is illuminated.

By the brightness of a celestial object, such as a planet or a star, is usually meant the whole quantity of light received from it, the object being so distant as to present no sensible area. But, when the object is within limits of distance small enough to enable it to present a sensible area, its intrinsic brightness, in the true sense of the expression, does not alter for variations of x within those limits, provided that r is constant.

In the preceding investigations, brightness simply means the whole quantity of light received from the interior planet, and not its intrinsic brightness, which depends only upon r, its distance from the sun.

It is assumed that the albedo of the planet is uniform, and that the brightness is unaffected by the inclination of the surface to the lines IS or IE. Neither of these assumptions is strictly correct.

The expression, $\frac{1 + \cos i}{2r^2x^2}$, upon which L depends, may be written

$$\frac{(x + r)^2 - R^2}{4r^3x^3} \quad - \quad - \quad - \quad - \quad - \quad - \quad (3)$$

Now, when the orbits are elliptical, r and R vary as well as x. The brightness, L, is a maximum when (3) is so. But, for elliptical orbits, the maximum value of (3) can be found only by trial. For Venus and the earth, we may, without serious error, assume r and R to be constant, and use the formulæ (1) and (2). But for Mercury and the earth we cannot do this, on account of the eccentricity of Mercury's orbit.

For circular mean-distance orbits, Mercury is most brilliant at elongation 22° 19′, and distance unity, 3¾ days before eastern and after western maximum elongation. The illuminated phase is then 0·60. The brilliancy of Mercury is tabulated for every fifth day in the American Ephemeris for 1900, and the following table shows how greatly the planet departs from the data derived from a circular orbit. I select a few of the maximum tabulated values of L.:—

Date.	Phase.	x.	L	Remarks.
1900.				
2 March -	0·700	1·073	71·2	About 6 days before maximum E. elongation.
31 May -	0·977	1·319	67·6	About 1½ days after superior conjunction. Planet invisible.
29 August -	0·809	1·172	68·8	About 10 days after maximum W. elongation.
7 November -	0·392	0·843	45·5	About 8½ days after maximum E. elongation.
2 December -	0·427	0·881	55·6	About 5½ days before maximum W. elongation.

Mercury was at perihelion on 3rd March, 30th May, and 26th August, and this clearly has an important influence on the brilliancy of the planet near those dates.

The phase decrease after greatest E. elongation, and its increase before greatest W. elongation, are very rapid if the planet is near perihelion at the corresponding elongation.

I may add that our estimate of the actual brilliance of Mercury will be affected by the planet's altitude and the duration of twilight.

Mr. Denning, in a very interesting and valuable article ("Nature," 1st March 1900), states as the result of experience, that, in the evenings of spring, Mercury is usually most brilliant some 10 or 12 days before maximum eastern elongation.

For this year (by Washington mean time) L was 64·9 at noon on 25th February, 71·2 on 2nd March, and 64·5 on 7th March, maximum eastern elongation occurring at 18^h on the 7th. From these values it would appear that the greatest brilliancy occurred this spring only some six days before maximum elongation.

After 7th March the brightness rapidly falls off, and L is only 19·8 at noon on 17th March.

For Venus and the earth in circular orbits the greatest brillancy of Venus occurs about 34½ days from maximum elongation, when the planet is distant 0·430, has a phase of 0·270, and an elongation of 39° 43′.

This year, by the "Nautical Almanac," Venus is most brilliant on 31st May, 33 days after maximum E. elongation, at a distance 0·455, and with a phase of about 0·280; and again, on 13th August, 34 days before maximum W. elongation, at a distance 0·449, and with a phase of about 0·278.

For circular orbits I make the greatest brilliancy of Venus about 24 times that of Mercury. This year, by the American Ephemeris, Venus (31st May) exceeds Mercury (2nd March) in brightness only about 14 times, as Mercury is more, and Venus less, brilliant than they would be in circular orbits. Were the two planets equal in size and albedo, then, for circular orbits, the greatest brilliancy of Mercury would be nearly half as large again as that of Venus. I assume the albedo of Venus to be $5\frac{1}{2}$ times that of Mercury.

Appended is a table of results for several pairs of planets, supposed to be at mean distances from the sun, and in circular orbits.

Planets.	Ratio.	Elongation.	Distance.	Phase.	Remarks.
Mercury from Venus.	0·535	Brightest - 31° 36′	0·537	0·40	Greatest brilliancy after E. and before W. maximum elongation.
		Maximum - 32 21	0·611	0·50	
Mercury from Earth.	0·387	Brightest - 22 19	1·000	0·60	Greatest brilliancy before E. and after W. maximum elongation.
		Maximum - 22 47	0·922	0·50	
Venus from Earth.	0·723	Brightest - 39 43	0·430	0·27	Greatest brilliancy after E. and before W. maximum elongation.
		Maximum - 46 20	0·690	0·50	
Earth from Mars.	0·656	Brightest - 37 8	0·822	0·30	„ „
		Maximum - 41 1	1·150	0·50	
Mars from Jupiter.	0·293	Brightest - 12 37	6·092	0·83	Greatest brilliancy before E. and after W. maximum elongation.
		Maximum - 17 2	4·975	0·50	
Jupiter from Saturn.	0·545	Brightest - 32 7	6·915	0·39	Greatest brilliancy after E. and before W. maximum elongation.
		Maximum - 33 3	8·000	0·50	
Planet I. from Planet E.	0·447	Brightest - 26 34	0·894	0·50	Greatest brilliancy at E., and at W. maximum elongation.
		Maximum 26 34	0·894	0·50	
Planet I. from Planet E.	1·000	Brightest - 48 11	0·000	0·17	The limiting theoretical case.
		Maximum - 90 0	0·000	0·50	

Leeds, 31st March 1900.

The Canals of Mars.

By EDWIN HOLMES.

The suggestion so well argued by M. Antoniadi that the alleged duplication of the so called "canals" of Mars is the result of a slight defect of focus was rejected by Mr. Goodacre in his paper last month, after full consideration of the statements of Mr. Stanley Williams. While not accepting the objective reality of the doublings, he thinks the appearance must result from some peculiarity of eyesight. Mr. Stanley Williams is very moderate in his statements, and they are not exactly in line with those of Messrs. Flammarion, Schiaparelli, and others. He appears to

claim that there are some features on Mars roughly in duplicate, and that sometimes one is visible, sometimes the other of the two, sometimes both, and sometimes neither. He regards the "canals" apparently as permanent features of the planet, which from some cause are not always visible. His canals are respectable members of society, not given to wandering about on the face of the planet nor to changing direction like a wind vane. This is a distinctly different attitude to that of M. Flammarion, who says that sometimes the double canals are not either of them in the place of the old one, and that they may vary in their aspect,—their configuration, their length, their breadth, and even their direction. I am at a loss to understand what means of identification is left—where every attribute is changed. We have here a distinct divergence of description.

I believe the peculiarity of sight that results in the duplicity of so called canals, lakes, &c., is simply astigmatism of either eye, or instrument, or both combined. A slight amount of astigmatism may easily exist unsuspected. Not possessing any astigmatism myself, I have had for experiment to render my eye astigmatic by using either a tilted convex lens or a cylindrical lens. On making a black cross on white paper and examining with the tilted lens I find one or other line broadens diffusely, and with a look of duplicity, while the other remains sharp, the distance of the lens from the object deciding which line remains sharp. When the horizontal is sharp the vertical line appears double and *vice versâ*. Using the cylindrical lens and a "star" of lines for object, one line is seen sharply and all others at various inclinations to it are doubled in a manner that agrees very well with the description of the doubling of lines on Mars, and they first become fuzzy and indefinite, and then give the idea of two lines with a misty look between. A tilted spectacle lens is quite sufficient to duplicate lines. We thus have sharpness of image in one direction with less sharpness and apparent duplicity in others. This suggestion in no way conflicts with M. Antoniadi's or Mr. Goodacre's ideas, but merely adds thereto an explanation how sharp and yet defective focus may exist at the same time.

It has been previously remarked that the name of "canals" as applied to the dark streaks on Mars was a little unfortunate, and it is also explained that it does not really matter, the term being merely used in a technical way, and not as implying that the so-called canals are artificial productions or even water at all, and that the terms seas and bays are merely convenient ways of referring to these details, and do not in any way prejudge the question. I am afraid the explanation does not suffice to remove the impression. You cannot constantly allude to a man as "that nigger," however much you explain that you do not mean to imply anything about his colour, without creating an impression that he lacks something of desirable whiteness. The name of canals applied to the streaks has caused speculation into their character to be mostly directed to hypotheses in which water plays a principal part. Besides, it is not consistent with facts that these terms are only used as a convenient way of reference, for having called them canals (with the reservation) many writers, M. Flammarian, for instance, treat their watery nature as an ascertained fact, and repeatedly allude to them as "watercourses," so that a

reader of their writings inevitably becomes imbued with the idea that no doubt exists on the matter at all. I fear the direction given to observation and deduction by the tacit assumption that the phenomena of Mars are due to water, all water and nothing but water, is somewhat injurious.

The word canal is also used very loosely. The prolongation of the Kaiser Sea is alluded to as a canal. Some observers declare they have never seen a canal at all, but if this prominent marking is a canal, all observers have seen at least one. I am not aware anyone has seen this double. It is evident the term is somewhat elastic, and, if used, I think it should be settled whether it is to applied to all kinds of dusky shadings, or restricted to the narrow and straight, or slightly curved bands with which most of us associate the name. A "canal" hundreds of miles wide is a large order in the way of excavation.

It is also unfortunate that M. Schiaparelli was not content with discovering so many new features on Mars, but must also discover an entire new set of names for the old features. The observers who preceded him brought into use a certain number of definite designations which could have been added to on the same lines without burdening us with two or three sets of names. The only reason I can see for this attempt to discard the old names is that they were of English application, and so hurt the self-love of all who are not English. At any rate the selection of new names seems to have been made on the principle that no English need apply, and to be influenced by the same antipathy that makes our friends across the Channel desirous of removing the initial meridian to pass through Jerusalem or the Canaries, or in mid-ocean (because water is a more stable element than land), or anywhere so it does *not* pass through Greenwich.

The names chosen are in many instances of unnecessary length, causing us to have to write or pronounce four or five syllables where two or three would suffice. And they are a remarkably evil sounding lot. They always remind me of the old lady who found Nebuchadnezzar or Beelzebub such a comforting word.

I think we should also object to the unnecessary multiplication of names for parts of one and the same feature. I see this has its use in apparently multiplying discoveries and adding importance to lists of observations, but instead of adding to knowledge this only adds to our burdens.

Observers who have seen most of the canals and the doubling of canals are Schiaparelli, Perrotin, and Lowell, supported by Terby and Brenner. I have no knowledge of the original drawings, but as the reproductions have been published for the purpose of elucidating and emphasizing the discoveries and to prove changes and floods, I suppose they fairly represent the originals. Well, to my mind the drawings do not warrant the charts made from them. The vast majority represent loose vague shadings, not of an incredible character, and in only a few instances the planet is covered with fine and sharp lines. A great many discoveries have been made when the planet was 10″ to 11″ diameter, and at least one canal seen when the planet was only 5″·7. At this time 1″ of arc would represent about 700 miles. On a disk of 9″ it represents 470 miles. I am not concerned as to exactly what separation is necessary to show a double canal

under such conditions. Mr. Goodacre finds the separating power less than for double stars, and, I think, rather understated his case. I believe he referred to the separation of sharp and distinct lines with good contrast, which we do not get upon Mars. Upon faint and ill-defined markings the separating power would be much less, but admitting that 1″ of arc might be separated, we are confronted with the fact that this would still almost amount to 500 miles.

Mr. Maunder referred to his own experiments on the smallest visible object which he found to be about 40″ for a dot and 8″ for a line. I apprehend that this is the limit for a dark object on light ground and that a white, and especially a bright, object would be visible when much smaller. In fact, if sufficiently bright, I believe there is hardly any limit to visibility. As an instance, a star which does not subtend one hundredth of a second is perfectly visible to the eye, and a gaslight not over three inches in diameter is visible easily at 10 miles when it is little over 1″ of arc, but in each case it makes the impression on our retina of the magnitude mentioned by Mr. Maunder. A dozen gaslights in a space two feet diameter would still appear as a single object at 10 miles. The question of the minutest point visible is thus a question of contrast as well as dimensions, but our retinal impression is the same, however minute.

But to return. The drawings of Schiaparelli and Perrotin are demonstrably incorrect. Mr. Green pointed out that they do not draw the established features of Mars correctly. They also draw canals straight, both on central meridian and far from it, and they draw double canals about as far apart whatever their position on the disk (*see* "L'Astronomie," page 210, 1889), and the canals are not much reduced in breadth with increasing distance.

These results are difficult to account for if their duplicity is regarded as objective. With regard to the other observers Dr. Terby well studies what he ought to see, and is influenced by his desire to confirm Schiaparelli. Herr Brenner has with 7-in. measured the diameter of the Satellites of Jupiter to the $\frac{1}{1000}$ of a second, and the difference of their polar and equatorial diameters. He has settled the rotation of Mercury and of Uranus, and he has seen 121 canals on Mars in one apparition. Prof. Lowell has gone so far as to assert that "the configurations on Venus have "always been very sharp, as sharp, in truth, as those of the "moon." "Not only are these lines permanent, they are con-"stantly visible, and nothing ever hinders seeing them except "the clouds of our own planet. These spots being constantly "visible, there are no clouds upon that planet." After that I dismiss him without further comment.

These canals are admittedly difficult and delicate objects, and error or delineation of what is at the limit of vision is probable if not certain, and my object in referring to these inaccuracies is to emphasize the necessity of rejecting all evidence of change based on differences of drawings. M. Flammarion says, "we must not "take differences of drawings for real changes upon the planet," but this is what he actually does continually. Although he allows much for error, he concludes there is strong proof of

change on no other grounds. The utter unreliability of drawings *for this purpose* is evidenced by referring to a few. In "Knowledge," March 1, 1895, is a drawing by Secchi, and another by Green, 36 minutes later. The differences are as great as in any with years betwixt. In "L'Astronomie," p. 182, 1889, are two by Keeler and Holden, 15 minutes apart, also two by Holden and two by Keeler, with intervals of 12 minutes and 24 hours 40 minutes respectively, and on page 209 are drawings by Secchi and Lockyer, 36 minutes after, "two of their best drawings." They differ so much that I think it impossible to say anything that would strengthen the case a bare inspection of them presents; yet whole chapters have been written upon changes deduced entirely from drawings.

I think more must be allowed for the atmosphere of Mars than is usually done. M. Flammarion says the atmosphere of Mars is generally pure and usually quite free from clouds, and that we get a view of the planet only interfered with by the vagaries of our own atmosphere. Admitting much less cloudiness than we are familiar with, we probably have much interference of a minor character. The growth and decay of the polar caps proves considerable atmospheric disturbance. The material, whatever it is, is evaporated from one part and condensed on another, and mists and haze occur according to seasons and hours which, while invisible as such to our telescopes, yet would affect the appearance of the planet to a considerable extent. Clouds would be indistinguishable from the body of the planet. We know that a very substantial body may be suspended many thousands of miles above Jupiter, and yet be perfectly invisible, so that clouds would certainly appear to form part of the surface of Mars, and then local fogs or haze would dim or hide both large and small detail in a very irregular manner.

Many explanations have been offered of the singular network pourtrayed by M. Schiaparelli. There is one I am surprised has been overlooked so long, especially by those fond of inventing methods of communicating with the Martians. It has been suggested that if an enormous triangle were laid out on the Sahara, or an illustration of some other geometrical problem, the Martians would see and comprehend its meaning. I make a present to those concerned of the idea that the Martians have been a long time laying out triangles and parallel lines in order to communicate with us, and that the tracing which puzzles is simply problems [in geometry set for our benefit. There is no reason why the attempt to communicate should not begin at their end of the line as well as ours. But if they are a kind of beings more advanced than we are, and arrived at the notion of the desirability of a planetary post office ages ago, I am sorry for the amount of energy probably wasted, considering that during the whole term of existence of the earth, it is only during a portion of the last 100 years that even such gigantic lines as the so-called canals of Mars could possibly have been perceived by the inhabitants of earth. I add nothing in support of the idea, except that it is at least as probable as some other explanations that have seen daylight.

Considerations on the Double Canals of Mars.

By Eugene Antoniadi, F.R.A.S.

I.

I must apologise for the delay with which this paper is written. But, having been asked to represent in colours, and on a large scale,* the planets as seen by myself at Juvisy, I was obliged to swerve for a considerable time from my usual observational work in order to represent to the best of my ability, the symbolism of my states of consciousness on the physical appearance of these worlds.

Since the publication of my short preliminary note ("Journal," p. 120), I was glad to find a second paper of Mr. Stanley Williams on the doubling canals. I note, however, that, in answer to my objection that the extra-fugitive visibility of the canals necessarily baffles any attempt at a direct experiment on the planet, Mr. Williams affirms that the plainer canals "*are* continually visible" to him. To this statement, however, I will oppose my own experience, obtained with a more powerful telescope, in 1894, 1896–97, and 1898–99, which is decidedly antithetical to the notion enunciated by the Brighton observer. Under no circumstances whatever could I keep a Martian canal steadily before me, affirming that, at best, *the canals appeared to me invariably by glimpses only*, every glimpse rarely lasting more than a small fraction of a second. The visibility of these markings thus became, to some extent, a mere function of patience and perseverance.

The remarks of Mr. Maunder on the "miraculous" character of Mr. Stanley Williams' observations are extremely interesting. I may add here that I, too, have followed for years Mr. Williams' work, and joyfully endorse his brilliant discovery of dark spots on Saturn's belts. But the function of science being that of sweeping the miraculous from its battleground and seek to place every natural occurrence upon a cause, it may be stated, from personal experience that small apertures suit these spots very well indeed,† and that they could not really be missed by a careful observer who, moreover, had paid much attention to kindred markings on a brother planet.

The scope of a given telescope is, logically, a limited one. Nothing can be more dangerous than trying to transgress its boundaries, as a consideration of the following arguments will, I think, prove beyond doubt.

In the summer of 1899, Mr. Stanley Williams expressed to the writer his conviction that the centre of Jupiter's "red" spot preceded, and no longer followed, the centre of the "bay." Now this was in utter contradiction with M. Flammarion's and my own experience at the time. Fortunately, however, for the cause of truth, we can, in this case, do more than oppose antithetical

* Jupiter with a major axis of $7\frac{1}{2}$ feet; Saturn with a major axis of his outer ring of nearly 12 feet; and a $12\frac{1}{2}$ feet chart of Mars on Mercator's projection, embodying Signor Schiaparelli's discoveries up to 1886.

† The full aperture of the Juvisy equatorial proved less effective on Saturn's spots than when stopped down to 6 inches. Spherical aberration might, however, account for this.

records, by quoting the contemporary statements of other observers; "the centre of the spot," says Mr. Gledhill, whose experience of this marking runs back to 1869, "seemed to be in "about the same latitude as the south edge of the great *f* shoulder, "and its longitude was a little behind that of the middle of the "hollow; in other words, the ellipse seemed to be not quite sym-"metrically placed with reference to the shoulders and the hollow "between them."* Also the Rev. T. E. R. Phillips says, in a letter to the writer, "I still consider the spot to be not centrally "placed in the 'bay,' but a little towards the *f* end" (1899, July 23). Finally, Mr. Denning writes,† "notwithstanding Mr. A. S. "Williams's observations, I still see the red spot a little on the "following side of the hollow. Mr. Phillips also agrees, for in a "letter to me, dated August 14th, he says 'whenever I have seen "'the complete oval of the spot it has *always* appeared to me "'slightly *f* the centre of the hollow.'" The question is thus raised to unmistakeable clearness. In perfect harmony with natural law, the 6½-inch reflector cannot outstrip the weightier evidence and independently converging testimony of powerful telescopes. We thus reach an irrefutable confutation of the notion enunciated by Mr. Stanley Williams that in 1899 the "red" spot preceded and did not follow the bay in which it is located.

One word more, with reference to the results of the Brighton observer in his recent experiments on Mars. On pp. 115–16, he says that "when put out of focus, single canals became simply "indistinct." Now, connecting this statement with Signor Schiaparelli's remark that the most perfect type of a canal is a dark or black line ruled with the pen on the yellow continents, we are forced to the conclusion that indistinct vision *must* give to such canals the aspect of dark bands with fainter lateral shadings, and that the concomitant apparition of "lakes" on their intersections should also come in at this stage of their (optical) evolution, as expressed by me in p. 270, Vol. IX. of the "Journal." And thus, my only claims upon the optical theory receive full confirmation at the hands of Mr. Stanley Williams, becoming, as they do, inevitable optical corollaries of his own experiments.

(*To be continued.*)

* "Monthly Notices, Royal Astronomical Society, Vol. LX., pp. 49–50.
† Letter to the writer, dated 1899, August 21.

New Books and Memoirs.

Leçons d'Optique Géométrique, par E. Wallon, Professeur au Lycée Janson-de-Sailly. (Paris, Gauthier-Villars, 1900.)

This work is based on a course of lectures given at the above college, and published at the request of the author's pupils. It is divided into 14 chapters, and deals with the entire range of geometrical optics without the introduction of any mathematical difficulties. The whole of the reasoning is remarkable for its simplicity and clearness, and the book can be easily and profitably read by anyone who has a fair knowledge of algebra and trigonometry. The following very brief summary of the most important chapters will, it is hoped, give the reader an idea of the contents of this well written and well arranged book.

In the chapter on photometry, the most accurate method of comparing two sources of illumination is fully discussed, and Bouguer's equation connecting the various quantities involved is established from the experimental result. There is also a short reference to standards of light.

In the four chapters on reflection and refraction at plane and spherical surfaces, the whole theory of mirrors, prisms, and lenses is thoroughly gone into, all the well-known constructions and equations being clearly explained. In the case of spherical surfaces, tables with diagrams are given to indicate the course of the rays after reflection or refraction, and to show the changes in the nature and position of the image due to the motion of the object. In the case of thick lenses, the utility of the principal and nodal points in the construction of images is shown.

The chapter on dispersion gives a short historical account of Newton's and of Charles's early experiments, with a description of the methods used by each in decomposing and recomposing white light. Reference is also made to chromatic aberration, spectroscopy, the reversal of lines, and spectrum analysis.

In the chapter on achromatism, the author shows how to combine prisms or lenses so as to secure the deviation required with as little dispersion as possible. The equations for astronomical objectives are given, and it is shown that the problem of achromatism in this case may be solved in a variety of ways, according to the size of the instrument, and the purpose for which it is to be used.

In the chapter on optical instruments, all the well-known forms of telescope are described, with figures. The advantages of Foucault's modification of the Newtonian are pointed out, and after giving details of Gregory's and Cassegrain's telescopes, the author states that both these forms have been completely abandoned, and that all recent large instruments are refractors.

In the chapter on the measurement of indices of refraction, the methods employed in the cases of solids, liquids, and gases are considered at some length, and in the chapter on the velocity of propagation of light we have a full description of the standard experiments and the results obtained. The last paragraph of the chapter deals with Foucault's comparison of the velocities of light in air and in water.

This book, though strictly an elementary treatise, constitutes a valuable addition to the literature of the subject, and may be recommended to all who take an interest in the science of optics and the theory of optical instruments.

V. J. B.

Recent and Coming Eclipses, by Sir Norman Lockyer, K.C.B. (Macmillan & Co.). Price, 6*s*. net.

It is not every eclipse observer who is fortunate enough to secure the services of the crew of a warship to assist him, nor is it, perhaps, every observer who would have perceived the possibilities latent in such a body of men. But the crew of the "Volage" in Lapland in 1896, and of the "Melpomene" in India in 1898, have shown, under the able tuition of Sir Norman Lockyer and his assistants, what a powerful engine of scientific research a British warship supplies. In these days of war it is gratifying to find that the British seaman is so skilful in the arts of peace, and that this truly "Handy Man" can use a prismatic camera as skilfully as he can serve a 4·7 gun. We echo Sir N. Lockyer's hope that the time may not be far distant when eclipse observation may be one of the regular duties of the Navy. In this volume Sir Norman tells the story of the expeditions organised by him to observe the eclipses of 1896 and 1898, and although the former was practically barren of results, so far as observations are concerned, yet the experience gained was of the greatest value in the successful observations made at Viziadrug in 1898. Written in a pleasant narrative form, with chapters explanatory of the problems towards the solution of which eclipse observations are directed, the book forms a very complete record of the general results obtained. The many hints as to the organisation and drill of a large party of observers are especially valuable coming from so experienced an "eclipser"—it is Sir Norman's own word. One very important point which the photographs obtained have revealed is the slight relationship which exists between the bright lines in the spectrum of the chromosphere and the Fraunhofer lines in

the solar spectrum. At the end of the volume are some useful notes on forthcoming eclipses; the eclipse of March 17 next year, visible at Mauritius, being specially noteworthy, the duration of totality varying from 5½ to 6½ minutes. The book is copiously illustrated, but the reproduction of the photographs is not always all that could be desired. We might, perhaps, point out a misprint of "Contracts" for "Contacts" in the list of observations on page 59.

Notices of the Association.

The next Meeting of the Association will be held at Sion College, Victoria Embankment, on Wednesday, May 30, chair to be taken at 5 o'clock.

The following papers have been received:—

Diffraction Gratings and Diffraction Spectroscopes. By ALBERT ALFRED BUSS.

The Ages of Sun-spots in Relation to the Eleven-Year Period. By WILLIAM ANDERSON, F.R.A.S.

New Members of the Association.

ELECTED 25TH APRIL 1900.

JOHN WALLER LAWRENCE CHILD, Vernham, Merton Hall Road, Wimbledon.

LADY McCLURE, Redford House, Colinton, Midlothian.

MISS JESSIE McRAE, 32, Birdhurst Road, Croydon.

J. O'CALLAGHAN, Slindon Cottage, Arundel.

ANDREW ROWAN, Fircroft Road Board School, Upper Tooting, S.W.

WILLIAM HENRY WALMSLEY, B.Sc., F.R.A.S., Nautical Almanac Office, 3, Verulam Buildings, Gray's Inn, W.C.

EDWARD WELDON, Didmarton, Tunbridge Wells.

Candidates for Election as Members of the Association.

30TH MAY 1900.

DONALD WILLIAM HORNER, F.R.Met.Soc.,
Milford Lodge, 82, New Park Road, Clapham Park, S.W.
Proposer—George Rice Orr.
Seconder—Ernest M. Brock, M.D.

WILLIAM THYNNE LYNN, B.A., F.R.A.S.,
21, Bennett Park, Blackheath, S.E.
Proposer—E. Walter Maunder. *Seconder*—W. H. Maw.

LOUIS F. OTTO,
Assistant Master,
Philander Smith Institute, Mussoorie, N.W.P., India.
Proposer—H. Mansell, D.D. *Seconder*—J. G. Petrie.

EBENEZER JAMES SEWELL,
Wavendon Manor, Woburn Sands, Bucks.
Proposer—Wm. C. Tetley. *Seconder*—Gertrude Farmer.

ARTHUR HOWE STEVENSON,
102, Riggindale Road, Streatham, S.W.
Proposer—W. H. Booth. *Seconder*—W. E. Stevenson.

Published May 16, 1900.

The Journal

of the

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VOL. X. SESSION 1899–1900. No. 8.

REPORT OF THE MEETING OF THE ASSOCIATION, HELD ON MAY 30, 1900, AT SION COLLEGE, VICTORIA EMBANKMENT.

W. H. MAW, F.R.A.S., *President*, in the Chair.

J. G. PETRIE, F.R.A.S., *Secretary*.

The *Secretary* read the Minutes of the last Ordinary Meeting, which were confirmed.

The names of three candidates for admission were read and passed for suspension, and the election by the Council of five new Members was confirmed.

The *President* said that before any papers were read those present might like to know what news had been received from Mr. Maunder and other Members of the Association who had gone out to view the eclipse of Monday, May 28. Several telegrams had been received, and, speaking generally, the observers at all the stations had been successful. There was a little haze and cloud at Ovar, where the Astronomer Royal and his party were observing, though not sufficient to do any harm. With that exception, none of the observers seemed to have been troubled with cloud. Mr. Maunder telegraphed as follows from Algiers:—
" Sky clear, observations successful; light at mid-totality much " greater than that from full moon. General shape of corona, " as seen by naked eye, resembled that of 1878. The longest " streamer of the corona, as traced by unassisted eyesight, ex- " tended to a distance from the centre of the sun of six lunar " radii; many photographs obtained." From Mr. J. Evershed, who observed at Mazafram, near the edge of the path of totality, no telegram had been received; but from the reports in the papers the eclipse appeared to have been barely total at his station. The results they did not yet know. It will be remembered that Mr. Evershed's special object was to obtain as long a duration as possible of the Flash spectrum.

Dr. A. M. W. Downing, observing near Madrid, telegraphed: "Sky clear; observations successful. Light at mid-totality "greater than that from full moon. General shape of corona, as "seen with naked eye, resembled that of 1878. Longest coronal "streamer traced by unassisted eye to a distance of four lunar "radii from sun's centre. Nine observers." Messrs. Howarth and Whitmell also telegraphed from Madrid as follows: "Sky "beautifully clear, observations very successful." From Elche, Mr. Johnson telegraphed: "Sky beautifully clear, observations "very successful. Light at mid-totality much greater than from "full moon. General form of corona, as seen with the naked "eye, resembled those of 1867 and 1889. Longest coronal "streamer traced by unassisted sight to four lunar radii from "sun's centre. Eight observers. Eleven photographs of corona "obtained, six sensitometer photographs, five photographs of "spectrum." From Manzanares Mr. H. Keatley Moore telegraphed: "Sky beautifully clear, observations very successful. "Light at mid-totality much greater than from full moon. "General form of corona, as seen with the naked eye, resem-"bled that of 1898. The longest streamer, as traced by un-"assisted sight, extended four lunar radii from sun's centre. "Three observers. No photographs taken of corona. Four "'gathering gloom' photographs taken, one sensitometer photo-"graph taken, no photographs of spectrum taken."

The *President* added that he thought these messages showed that a very good amount of work had been done. To remind Members of the forms of the corona in some previous eclipses, slides were thrown upon the screen illustrating the eclipses of 1878, 1889 (January and December), and 1898. The *President* said Professor Todd was to be specially congratulated upon the success of his observations at Tripoli. Professor Todd had been most unfortunate in his previous expeditions. He had spent a great deal of time and taken very great trouble to perfect his very ingenious arrangements for the automatic exposure of photographic plates, and if he had had good weather, as was reported, something very valuable might be expected from his observations.

Mr. G. J. Newbegin gave a short note (accompanied by a diagram) on the eclipse.

Mr. Adams asked if it were known whether the moon overlapped the sun's disk or not?

The *President* replied that it certainly did overlap, but the amount of the overlapping depended, of course, on the respective distances of the sun and moon from the earth at the time of the eclipse. There was at the time of the recent eclipse a difference of about 20″ of arc between the diameter of the moon and that of the sun, in favour of the former.

Mr. Hardy showed a photograph of the partial eclipse taken at Clapton at 3.55 p.m., with the camera, which he exhibited at a Meeting of the Association some few years ago, made expressly for the purpose of attaching to his telescope, and giving a disk of about 3-in. direct. He tried to see if he could get the slightest

idea of the corona, and did get some difference in the coloration of the plate around the sun; and this he proposed to check. Whether it was due to our atmosphere or to heat, he could not tell at the present time. Mr. Hardy added that this was a thing they might try to do without any eclipse at all.

Mr. Seabroke wondered whether any other observer of the eclipse noticed, as he had done, that the sun's limb in photographs taken during the eclipse appeared to be less sharply defined than the limb of the moon. He also remarked, in reference to the remarks already made on the possibility of seeing the moon on the background of the corona, that he understood the brightness of the corona at a distance of $\frac{1}{10}$ of the sun's radius from the limb was about one-half the brightness of the moon's surface when full.

Mr. W. C. Tetley, writing in reference to observations made at Wavenden Manor, Woburn Sands, said his party searched in vain to see if stars were visible either to a binocular or to the unaided eye. There was no great apparent diminution of light supply, and although the sky overhead was clear during the later phases of the eclipse, they could not succeed in making out Venus; nor was Mercury visible. The shadow passed at 4.57.

Capt. Noble, said that, owing to clouds, it was not until ¼h. after the time of the predicted time of first contact that he could get a glimpse of the sun. At the time of greatest obscuration, however, and again at last contact, the sky was beautifully clear. One feature which he particularly noticed was the extraordinary smoothness of the moon's limb. On all previous occasions when he had observed an eclipse he had seen the moon's limb more or less serrated. He observed the last contact at between 4.58 and 4.59, so he thought the tables must have been very slightly in error. He had that morning received a letter from which he wished to read an extract, to show how utterly untrustworthy any testimony coming from a person without any previous training in observation must be held to be. The writer—a lady—gave an idea of the eclipse from a lady's-maid's point of view. She said: "My maid "afterwards gave me a remarkable description of what occurred "at the end. She said the sun shook about and then turned "over." (Laughter.) "I would so like to know, quite at your "leisure, what occurred at the end, which I was obliged to miss. "It would be so nice to have a scientific account." (Laughter.) There could surely be no better illustration of the worthlessness of unscientific testimony regarding scientific phenomena.

Mr. Goodacre said he, like Capt. Noble, looked particularly to see if there were any signs of projections on the limb of the moon, and found it extremely smooth from one cusp to the other. He also noticed how clean and sharp the cusps were. He could see no sun-spots until the eclipse was nearly over. One thing that struck him was the remarkable difference between the brightness of the sun at the limb and that part of the disk which was in contact with the limb of the moon.

Mr. Holmes said the remarkable smoothness of the moon's limb had been referred to. He, on the other hand, had been

assured by three of the unscientific people to whom Capt. Noble had referred, that they, with the naked eye, using coloured glass, distinctly saw the lunar edge very irregular, as if it were all mountains. (Laughter.) Personally, he viewed the eclipse through a 12½-in. instrument stopped down to 7-in. aperture, and projected the image to 34-in. diameter with a Browning C eye-piece. At that size, the irregularities within the northern portion of the shadow were perceptible, but not very marked, and most of the time they were almost hidden by the tremulousness of our own atmosphere. There were two groups of spots visible; but as the moon reached the spots clouds came, as at first contact, and there was very little use in trying to take any time. He paid particular attention to the edge of the moon, in order to see if there was any sign of a lunar atmosphere, but he could see nothing of the kind. The cusps remained perfectly sharp, and the definition of the spots remained perfect when the moon was covering them. He was not able to detect any sign of the moon outside the sun, as on the background of the sky, either by direct vision or projection. The eclipse appeared to be over about 1½ min. before the time predicted.

Capt. Noble said he, like Mr. Holmes, looked particularly for the projection of the moon's limb on the corona, and utterly failed to see it. On the occasion of a former eclipse he was able to trace the moon's limb some four, five, or six seconds of arc beyond that of the sun, projected apparently on the corona. Again, on a former occasion, he saw two exceedingly tiny horns like the finest needle-points, as though the moon had a very slight atmosphere, and was refracting the sun's rays—an observation which was corroborated by Mr. Lister-Godlee, of the Chancery Bar. On Monday, however, he saw nothing of the sort.

Mr. Newbegin said a remark made by Capt. Noble had rather brought a thought into his mind. In giving the time of last contact, there was a difference between his wife's and his own times of five seconds (and he had given the mean between the two as being a fairly reliable time). He was now inclined to think he was able to see the moon even after the last contact, for in all probability when he called out to his son, who was taking the time, "last contact," he had then just lost sight of the moon. On the projection of the moon, his wife would not, of course, have seen anything of the sort. His son saw Venus, about 3.40, he thought. Another assistance which his son rendered him was to make five exposures with his camera, preceding and following the greatest phase, and he had that morning informed him (the speaker) that he could already detect a considerable difference in the strength of the light as compared with the first photographs he took. Mr. Phelps specially remarked about the cusps that "they looked as if they would prick you if you touched them." With regard to the limb of the moon, he (Mr. Newbegin) thought it would be found that the photographs would show a long indentation caused by one of the plains, though he could not say in what region of the moon. The atmospheric disturbance was very troublesome; it caused a considerable "boiling" all round the

sun's limb, and this was specially visible on the projected picture. The eclipse finished at Norwich one minute earlier than the time given from Cambridge. As far as he could test the drawings, making an estimate for first contact, it must have taken place at $111^{\circ}\cdot5$ from the northern point, last contact being at 112° from that point.

Mr. Smart handed in a photograph taken at $4^{h}\ 57^{m}$, showing the moon not quite off the sun.

Mr. Hardy hoped they would be favoured with some photographs taken at the earliest part of the phase, for he had very little doubt that the first indication he had of being able to see the shadow was when the moon was not only much lighter than it was expected to be, but he certainly felt sure that at the outset he could see the body of the moon beyond the sun. He had not begun to take any photographs at that time, but he thought the photographs taken would prove this to be the case.

Mr. Thwaites said he observed the eclipse with a 4-in. refractor, with driving clock, and before first contact he carefully examined the sky in the region of the point of contact, but he failed to trace any sign of the moon. He did the same after the eclipse, but with a negative result. He did not see the first contact on account of clouds, but saw the sun again about $1\frac{1}{2}^{m}$ or 2^{m} afterwards. The sky then became completely overcast, but cleared very much towards the middle of the eclipse. The extreme sharpness of the cusps was very noticeable, as was also the mottling of the disk. At the latter end of the eclipse the definition was very good, and the surface of the sun was beautifully mottled. He was using a low power of about 56 diameters on account of his desire to get a large field, and observe the whole of the sun. With reference to the sharpness of the cusps, they seemed to him to be truly geometrical, if he might use that term. There was no lengthening-out of the cusps, the two arcs seemed to cut one another sharply and distinctly, thus showing no trace of atmosphere on the moon. As the moon's limb advanced over the sun, its granular surface and the two groups of spots remained quite as distinct as before.

The *President* asked whether any Member obtained any observation of prominences during, or immediately before, the eclipse? If any such observations were obtained, a comparison of them with the eclipse photographs later on would be very interesting.

(No Member appeared to have made this observation.)

Mr. Holmes said he noticed the mottling of the disk, to which Mr. Thwaites had alluded, as being very marked. The following group of spots appeared to be much less distinct after the greatest phase than it was before. He was able to count nine separate spots before, but only three after, the greatest phase. One point no other speaker had mentioned was that there was a considerable falling off in the light during the eclipse, and a still greater diminution in the heat. He had a zinc stop in the mouth of the telescope to reduce the aperture, and before the eclipse he could not

bear his hand upon the zinc; but at mid-eclipse it did not feel any warmer than the hand.

Mr. Thwaites was able to corroborate what Mr. Holmes had said as to the falling off in the light, which was very marked. Of course it was nothing like so pronounced as he saw in India on the occasion of the 1898 eclipse, but the effect was approximately the same; the grass had a peculiar colour, as if a very dark thunder cloud had obscured the sky, this gradually disappeared as the light returned. He did not notice the spots to differ either in sharpness or number. The definition improved very much from mid-eclipse to the end, there doubtless being a haze at the beginning of the eclipse, which was not visible to the naked eye.

Mr. Newbegin said the light of the sun seemed very much as on a "watery" day—when rain was coming—and they looked around and could not see the disk of the sun.

The *President* was able to confirm what Capt. Noble had said about the apparent smoothness of the limb of the moon. He personally was unfortunate in his observation of the eclipse, for at Kensington the sun was obscured by cloud until about 3.50, and he only obtained a view from then until about 4.7 or 4.8. During that time, however, there were some minutes of exceedingly beautiful definition, and the mottling of the solar disk was beautifully defined. He noticed no notches on the moon's limb, as seen with an ordinary low power of about 126. He subsequently used a Dawes eye-piece, and examined the moon's limb with a small stop so as to be able to see about 5° in length of the limb. Travelling around the limb in that way he found two small notches that he could make sure of, and one that he could not be certain about. In all the cases the mottling on the sun's disk was perfectly defined right up to the moon's limb, and there was no indication whatever of any lunar atmosphere. He was sorry no one made any spectroscopic observations, for it would have been interesting, as he had previously said, to have sketched the prominences which were visible here, and compare them with those shown on photographs taken where the eclipse was total. He himself tried on the day preceding the eclipse, but the haze was so strong that he could not see any prominences. On Monday he would have tried after the maximum phase had passed, but clouds came over, and he could do nothing in that way.

Mr. Wm. Anderson contributed a paper on "The Ages of Sun-"spots in Relation to the Eleven-Year Period." (*See* p. 318.)

Mr. Holmes asked what reason there was for supposing that spots should begin to form at one limb of the sun rather than at the other. They came on at one limb if they were in existence, but why should they originate at one limb?

The *President*. The writer of the paper rather takes the view that the appearance of a spot at the eastern limb indicates that it is not an old spot, but a comparatively young one.

Capt. Noble said it appeared that Mr. Anderson adopted a curiously arbitrary method of classifying his spots; they were new groups when he wanted them to be so, but sometimes they died and came to life again. He (the speaker) did not think it would be difficult to compile a table upon those principles which would prove anything. All doubtless recollected that Bret Harte took note of the number of people who went to bed every night in England, and also of those who travelled in railway trains; he showed how many people died in their beds, and how many were killed on the railway, and he thus proved that it was infinitely more dangerous to go to bed than it was to travel on the railway.

A paper on "The Double Canals of Mars," by Mr. A. Stanley Williams, was read. (*See* p. 323.)

Mr. Goodacre said he would like to read Mr. Stanley Williams's paper in print before saying much about it. There was one point in Prof. Pickering's experiments which had struck him, and to which Mr. Stanley Williams had alluded, viz., Prof. Pickering, as the result of the examination of Schiaparelli's maps, found that with an increase of aperture the space separating the canals was reduced in proportion, *i.e.*, with 8½-in. aperture they were twice as widely divided as when using an aperture of 18-in., the inference being that with 36-in. aperture the two lines would be merged into one, and this would, perhaps, account for observers using the Lick and other large telescopes not being able to see double canals on Mars.

A paper on "Diffraction Gratings and Diffraction Spectroscopes," by *Mr. A. Buss*, was next read.*

At the conclusion of the reading of Mr. Buss's paper, the *President* stated that Mr. Thorp had kindly sent for exhibition a selection of the reproductions of gratings made by him, to which reference had been made by Mr. Buss. The President added that some of these reproductions were made from Rowland gratings, and others from an echelon grating cut in metal by Mr. Thorp himself. The results obtained were admirable, and Mr. Thorp deserved hearty congratulations on the success which had attended his work. He (the President) hoped that on some future occasion they would be able to persuade Mr. Thorp to give them a paper on these gratings.

A discussion then ensued, in which *Mr. Newbegin*, *Mr. Thwaites*, and others took part, and Mr. Buss was thanked for his interesting and thoroughly practical paper.

The Meeting adjourned at 7 p.m.

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* Unavoidably held over until Journal No. 9.

Reports of the Branches.

NORTH-WESTERN BRANCH (MANCHESTER).

The Eighth and final Meeting of the present Session was held on May 2, when the President, Prof. T. H. Core, M.A., occupied the Chair.

The Director of the Lunar Section, Mr. Goodacre, had kindly sent down a number of photographs and detail drawings of the moon, which, together with the descriptive letter accompanying them, were appreciated by the Members. Mr. MacEwen also, Director of the Mercury and Venus Section, had forwarded over 20 recent drawings of the planet Venus and these were the subject of pleasurable comment.

A paper on "Sir William and Caroline Herschel, and their "influence on Modern Astronomy," was next read by Mr. S. Okell, F.R.A.S. The lecturer disclaimed any original information as most of his matter, he stated, was culled from the interesting pages of Miss Agnes Clerke's able little volume on the subject. The Members were extremely gratified with the graphic sketch of the lives and work of these able pioneers in Astronomical work, and accorded a hearty vote of thanks to Mr. Okell for his paper.

VICTORIA BRANCH (MELBOURNE).

The Second General Meeting of Session 1899–1900 was held at 31, Queen Street, Melbourne, on Thursday the 5th April 1899, at 8 p.m. The Rev. J. Micklejohn, M.A., President, in the Chair.

The Chairman referred to the sudden death of Dr. Sprigg, who was elected as one of our Vice-Presidents at our last Meeting. The deceased gentleman was most regular in his attendance upon the Meetings, and took a most active interest in the Society.

Mr. E. F. J. Love, M.A., F.C.P.S., was elected as Vice-President to fill the vacancy.

Mr. George Smale read a most interesting paper on "The New Planet Eros," which he illustrated by diagram showing the motions of the Earth, Mars, and the new planet. Mr. Smale was highly complimented for the manner in which he dealt with the subject.

A vote of thanks to the lecturer was proposed by Mr. Sugars and seconded by Mr. Miller. Carried unanimously.

Papers communicated to the Association.

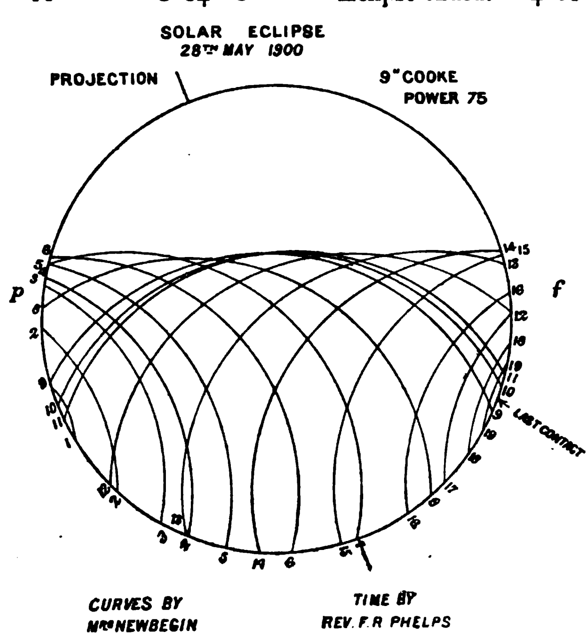
Solar Eclipse, 28 May 1900.

By G. J. Newbegin, F.R.A.S.

The Eclipse was observed at the 9-in. Cooke by Mrs. Newbegin and Rev. T. R. Phelps in projection, the image produced being about 4·2 in diameter.

The first contact was not seen, but very soon after the first curve was drawn at $2^h\,47^m\,54^s$. The second curve, and the third also, are incomplete, there being just time to mark the extremities. All the remainder were drawn without much trouble and a fair absence of cloud. The last contact is marked by a dot, and the time was noted as $4^h\,55^m$. The No. 10 curve appears to be very near the maximum of obscuration.

		h	m	s			h	m	s
Time,	1 curve,	2	47	54	Time	11 curve,	3	55	15
	2	2	52	38		12	4	4	0
	3	2	59	34		13	4	14	0
	4	3	6	11		14	4	24	0
	5	3	11	11		15	4	35	0
	6	3	21	12		16	4	45	0
	7	3	31	15		17	4	50	0
	8	3	41	28		18	4	53	0
	9	3	51	28		19	4	54	30
	10	3	54	0	Eclipse ended.		4	55	0



The Ages of Sun-spots in relation to the 11-year Period.

By WM. ANDERSON, F.R.A.S.

Three methods are available for the purpose of comparing the ages of sun-spot groups in different years. We may (1) compare the mean ages of such groups as have been observed from their actual beginning to their ending in each year; or (2) compare the relative ages obtained by dividing the mean number of groups per day on the sun's visible hemisphere (excluding days without spots when obtaining the mean) by the mean number of new groups per day, the latter being obtained by dividing the total number of new groups in each year by the number of days of observation on which one group or more was visible; or (3) compare the mean number of days in each year on which a group was under observation. The first of these methods, although the only one which gives the actual ages of the groups, is wholly unreliable, and may yield entirely erroneous results; for an undue proportion of short-lived groups will almost certainly be included, and the percentage of these varies greatly, as we shall see further on, throughout the 11-year period; besides which the chance inclusion of a few very long-lived groups which happened to have both originated and died on the visible hemisphere, might greatly raise the mean age thus obtained for that year. The second method does not give the absolute mean ages of groups, but gives a relative age which is comparable with the relative ages similarly obtained for other years. These relative ages, however, may also lead to erroneous conclusions unless they are studied in connexion with the results obtained by the third method. The latter is much more satisfactory in every way; but the second method is well worth considering, since it confirms the results given by the third; and as both are necessarily only approximations, such confirmation is worth having.

In the present paper I propose to examine the records for the years 1891 to 1899 inclusive by the second and third of these methods. The data used are taken from the Memoirs of the Solar Section of the Association, and from my own observations; those for 1899 being from my own observations obtained on 276 days, or 23 days per month on the average.

The several columns of figures given below, are as follows:—

A contains the mean number of groups per day upon the disk. The figures in this column have been obtained by dividing the sum of the daily number of groups visible (as recorded in the "Calendars" of the "Memoirs") by the total number of days of observation, including days without spots. The curve X in the accompanying diagram has been obtained from these figures, and represents the curve of spot-periodicity considered in relation to the number of groups. In character it agrees with that obtained from the Greenwich mean daily areas of whole spots.

B also contains the mean number of groups per day upon the disk, but with this difference, that days of observation on which there were no spots have been excluded in obtaining the mean. It thus gives the mean number of groups on the disk on days upon which spots were visible.

C gives the total number of groups in each year. In the "Ledgers" of the "Memoirs" return groups receive new numbers, and in many instances are not noted as being returns. Each group had, therefore, to be separately examined, and if it lived to reach the west limb a search was made forward to find whether it returned or not, and if it returned, how often. The number of return groups so found was then deducted from the total number of groups recorded in the Ledger, including the interpolated groups, *i.e.*, those marked with an asterisk, or with a letter A, B, &c. In this way the 1699 groups of the nine years were reduced to 1593. No doubt the "personal element" comes in here, for it is often difficult, if not impossible, at and near the time of maximum to be certain whether a group at the E. limb is a return or not. I have, however, been guided by the recorded histories of such groups during their previous passages across the disk. For example, as there is a well-marked tendency in the case of scattered groups of small spots to die out and reappear later on in much the same position, if such a group was markedly decreasing when it reached the W. limb, but reappeared at the E. limb with renewed activity, I have treated the return as a new group (unless it possessed some specific characteristic), since it probably died and broke out again; but if only one or two small spots reappeared and soon died, I have considered them as a return. The different rates of rotation in different latitudes have also been kept in mind where the longitude of a group rendered its identity difficult. Where reasonable doubt still remained—and at the time of maximum there is a considerable number of such cases—I have treated the group as a new one.

D gives for each year the number of days of observation on which there were spots upon the disk.

$\frac{C}{D}$ is obtained by dividing the total number of groups (C) by the number of days on which spots were visible (D), and thus gives the mean number of new groups on each day upon which spots were visible.

$\frac{B}{\left(\frac{C}{D}\right)}$ The figures in this column are the relative ages mentioned above as obtainable by the second method; they are found by dividing the figures in Column B by those in $\left(\frac{C}{D}\right)$.

The last two columns give the differences from the means of columns A and $\frac{B}{\left(\frac{C}{D}\right)}$ respectively.

—	A.	B.	C.	D.	$\frac{C}{D}$.	$\frac{B}{\left(\frac{C}{D}\right)}$.	Differences from Mean in A.	Differences from Mean in $\frac{B}{\left(\frac{C}{D}\right)}$.
1891	3·12	3·26	129	348	0·37	8·81	−0·64	+1·90
1892	5·06	5·06	206	301	0·68	7·44	+1·30	+0·53
1893	6·41	6·41	274	338	0·81	7·91	+2·65	+1·00
1894	5·98	5·98	279	335	0·83	7·20	+2·22	+0·29
1895	4·83	4·83	231	329	0·70	6·90	+1·07	−0·01
1896	3·11	3·19	181	339	0·53	6·02	−0·65	−0·89
1897	2·42	2·66	145	302	0·48	5·54	−1·34	−1·37
1898	1·97	2·27	97	309	0·31	7·32	−1·79	+0·41
1899	0·94	1·52	51	171	0·30	5·07	−2·82	−1·84
	3·76		1593			6·91		

The curves X and Y in the accompanying diagram are obtained from the last two columns above; X, as has been already stated, representing the sun-spot curve as regards number of groups, and Y the relative mean ages of the groups obtained by the second of the three methods mentioned above. The dotted curve Z, representing the mean observed ages of the groups, shows the results given by the third and best method, and is obtained from the figures which follow. The observed age of each group has been counted from the day of its first appearance to the last day on which it was seen, including both, and is thus one day greater than the interval between the first and last appearance. In the case of every group which returned one or more times, the number of days from first to last appearance, including both, has been taken as the observed age of the group, although it was, of course, only under actual observation during a portion of this time. As in the other cases above, every group recorded in each year has been used in obtaining the mean. When a group originated towards the end of any year and was last observed in the following year, its entire age has been included in the year of its origin, but its appearance in the following year entitles it to be included in column C above, as having been visible in both years.

Mean observed Ages of Groups.

Year.	Days.	Diff. from Mean.	Year.	Days.	Diff. from Mean.	Year.	Days.	Diff. from Mean.
1891	10·29	+1·74	1894	8·95	+0·40	1897	7·28	−1·27
1892	9·53	+0·98	1895	8·54	−0·01	1898	7·49	−1·06
1893	9·40	+0·85	1896	6·61	−1·94	1899	8·82	+0·27
						Mean	8·55	

The curves Y and Z are as accordant as these approximate methods could be expected to make them as far as the year 1897, but their differences in 1898 and 1899 are so great as to require explanation. This, however, is forthcoming; but before stating it, it will be well to give the following table of the percentages of groups of various arbitrarily selected ages in the nine years under review.

PERCENTAGES OF GROUPS OF DIFFERENT AGES.

—	5 Days Old or Less.	6 to 10 Days inclusive.	11 to 15 Days inclusive.	16 to 25 Days inclusive.	26 to 40 Days inclusive.	More than 40 Days.
1891	35·1	28·3	26·7	0·0	8·4	1·5
1892	31·4	36·8	26·0	0·5	3·4	1·9
1893	35·9	29·7	28·2	0·0	4·8	1·4
1894	40·5	30·5	22·8	0·0	4·4	1·8
1895	44·6	27·7	21·9	0·0	4·9	0·9
1896	53·2	30·0	13·3	0·0	3·5	0·0
1897	60·6	19·0	16·8	0·0	1·4	2·2
1898	50·9	28·1	17·5	0·0	2·6	0·9
1899	54·0	32·0	6·0	0·0	2·0	6·0
Means -	45·13	29·12	19·91	0·06	3·93	1·85

By the third method of obtaining the relative ages of groups, from which the dotted curve Z is obtained, in the case of return groups, the days on which they were on the further half of the sun are included in obtaining their ages, while only the days on which they were visible are included by the second method, from which the curve Y is obtained. Thus, in the case of a spot which crossed the disk twice, assuming 14 days as the time occupied in passing from limb to limb, the age obtained for the spot by the third method is 42 days, while by the second method its age would be only 28 days, so that a high percentage of long-lived groups in any year tends to raise the curve Z relatively to Y. Conversely, a low percentage of long-lived groups raises Y relatively to Z. In the above table of percentages, it will be found that the years 1891, 1893, 1895, 1896, and 1898, have each a comparatively low percentage of groups which lived for more than 40 days, so that in these years the curve Y ought to be relatively high from this cause alone. And in the diagram this is found to be the case in all except 1895, in which year the comparatively high percentage of groups from 26 to 40 days old has just equalized the two curves. The years 1892, 1894, 1897, and 1899, have the highest percentages of very long-lived groups, and in each of these years the curve Z is found to be higher than Y; most notably so in 1899, in which year the rapid rise of Z has been chiefly produced by three groups which lived for 56, 85, and 49 days. This rapid rise of Z has been more than maintained for so far (April 12) in 1900, the mean age of groups during the 3¼ months being 12·75 days. The curve Y has also risen almost as rapidly, the relative age obtained by the second method, being 7·0 days.

If these 9¼ years may be accepted as typical so far as the ages of sun-spot groups are concerned, it would follow that groups

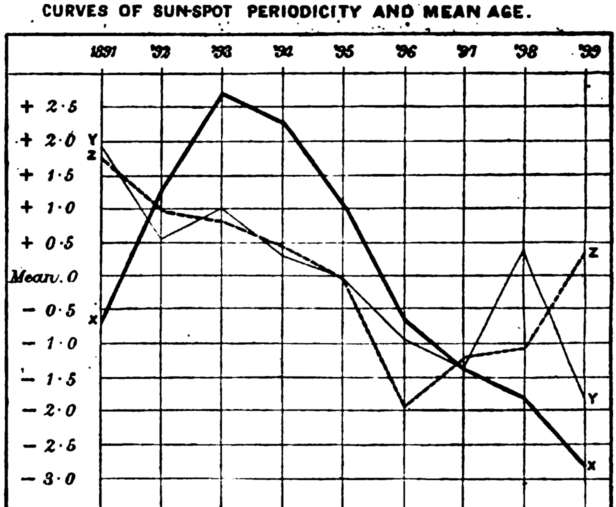
reach their maximum age at about the time of sun-spot minimum, while their minimum age occurs only three or four years previously. The curve of spot ages would thus appear to be not only periodical, but to have the same characteristic as the curve of spot-numbers, viz., the intervals from maxima to minima exceed by several years those from minima to maxima.

The mean number of days during which a group was under observation will be somewhat greater than that given in the foregoing table, viz., 8·55 days, as all doubtful return groups were treated as new groups, although it is reasonable to suppose that a number of them were actually returns. And as the majority of such groups occurred at and near the time of maximum, the curve Z would be higher at that time than it is here shown, were it possible to apportion the doubtful returns into return groups and new groups.

The above table of percentages brings out prominently the curious fact that groups between the ages of 16 and 25 days are almost entirely wanting. Only one group was found of an age between these two, and even in this instance it is open to question whether or not it died out on the further hemisphere, re-appearing again as such groups so frequently do, for it was decreasing when approaching the W. limb. It is numbered 215 and 223 in 1892, Group 9 of 1893 being possibly a re-appearance of its *following* end. Excluding its re-appearance on January 2, we get 21 days as its observed age. Seeing that many groups originate not far within, or to all appearance not very far beyond, the E. limb, and live to pass round the W. limb, but do not return, and that a number of such groups must have an age somewhere between 16 and 25 days, it is remarkable that this is the only group which appears, with any certainty, to have originated near the W. limb, and lived to re-appear at the E. limb, dying out within 25 days of its first appearance.

Madeira, 1900, April 12.

CURVES OF SUN-SPOT PERIODICITY AND MEAN AGE.



X – Differences from Mean in column A
Y – do. do. do. B (b)
Z – do. do. of ages of groups counted from first to last appearance.

On the Double Canals of Mars.

By A. Stanley Williams, F.R.A.S.

The interesting papers on this subject by Messrs. Antoniadi, Goodacre, and Holmes, published in the two parts of the "Journal" recently issued, and the discussions thereon, will no doubt have been followed with much attention, and, in fact, I shall consider myself most amply repaid if nothing else should result from my own contributions on the subject than that they should have been instrumental in calling forth so much valuable matter.* There are several things which require an answer on my part. The whole subject, however, is a very wide one, and would require a volume for its adequate consideration, whilst within the limited space available it is only practicable to discuss shortly a few of the questions at issue. Hence it must not be thought that there is nothing to be said from my point of view regarding certain other statements and objections simply because they are not alluded to here.

But, first, there is one rather important correction that requires to be made. It appears from some remarks dropped at a recent Meeting of the Association that there is an impression prevailing amongst some of the Members that M. Antoniadi's observations of Mars and my own are, to a considerable extent at least, in disagreement, and this impression is likely to be increased by M. Antoniadi's reference to what he seems to consider the "miraculous" nature of my observations ("Journal," p. 305). But this is erroneous, and there actually seems to be no real disagreement at all between us. We both of us have seen double canals, and also double "lakes," and in substantially the same manner, and the only respect in which we can be said to differ is, that whilst M. Antoniadi has not yet seen any canals *continuously*,† even on a good night, I have so seen the plainer canals. The only other difference between us is with respect to to the *interpretation* to be put upon things which both of us have seen, and I feel proud to find that my observations are in such close and satisfactory agreement with those of so skilful and practised an observer as M. Antoniadi.

* I venture to think, however, that I have conclusively shown that some at least of the observed duplications *must* have been real, and that they probably were so in many cases. And if this be admitted, even in a single instance, then the whole ground is cut away from under those who argue in favour of the optical or any other similar theory of duplicity, and it is no longer logical for them to hold that any particular case of observed duplicity must, *ipso facto*, be false. Further than this, probably, no one would wish to go. Any particular case of observed duplicity must be decided on its own merits by a proper discussion of the evidence available, just as in the case of any other observed feature.

† The fact that M. Antoniadi has only seen the canals themselves "by " glimpses only, every glimpse rarely lasting more than a small fraction of " a second," helps us to understand his observation of certain double canals in 1898 for a fraction of a second only on a single occasion. Doubtless he happened to be looking at the right spot just when an instant of sharper definition than usual permitted this more delicate detail to be seen. I was in some doubt before as to the interpretation to be placed upon the observation in question, but after this explanation I feel pretty certain that these canals were probably really double at the time. It also accounts for his having advocated the optical theory at all, as I do not think that anyone who has seen the canals continuously could be satisfied by this theory.

It may, perhaps, be due to my obtuseness, but I fail altogether to perceive in what way the optical theory can be said to receive full confirmation at my hands, as stated by M. Antoniadi (p. 306). In my first paper on the present subject (p. 116) I gave some reasons for thinking that the resemblance of the most perfect type of a canal to a black line ruled with a pen was really an effect due to contrast, and, moreover, to only a *slight* difference of contrast, and that there was really no analogy with an actual pen-and-ink line. A very little alteration of focus would suffice to reduce this slight difference of contrast, and the canal might naturally be expected to become indistinct and disappear *before reaching the stage of optical duplicity*, just as, in fact, was observed.*

On pp. 255 and 256 of the "Journal," Mr. Goodacre gives an interesting account of Prof. W. H. Pickering's experiments on the telescopic appearance of various markings on artificial disks. These experiments are of more than usual importance, because of the manner in which they were carried out, and in particular from the considerable distance which separated the object from the observer, owing to which the drawbacks arising from our own atmosphere were in great measure reproduced. But the great objection to these experiments is, that the objects viewed were all more or less of the pen-and-ink line type; and, as I have already pointed out, there are strong reasons for thinking that the canals of Mars are not really of this type at all. I am quite in agreement with Mr. E. W. Maunder in considering them to be probably formed, in a great many cases at least, of more or less detached spots, streaks, and stipplings which, at the distance, and under the conditions in which they are viewed from the earth, run together to form apparent lines or streaks.† For much the same reason the experiments on the minimum separation at which fine parallel lines could be perceived double are not strictly comparable with the case of the double canals. It is probable, also, that the latter, in some cases at least, more or less resemble a broad, dark band with a comparatively narrow, central bright stripe, and the question would then resolve itself into what is the minimum width a narrow bright streak on a dark surface must

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* I have dealt elsewhere with the question of the position of the red spot with respect to the hollow in the S. equatorial belt of Jupiter, a question rather remote from the present matters in discussion (*see* "The Observatory" for June), and I think it will be found that there are good reasons in favour of my view of the matter being the correct one, notwithstanding the authorities cited by M. Antoniadi.

† An excellent illustration of how a row of spots may run together so as to form a continuous streak or belt was presented in the autumn of 1893 to observers of Jupiter. Drawings by certain observers using small telescopes show a continuous dark belt between the NEB and the NTB; whilst other drawings made at the same time by M. Antoniadi with the Juvisy $9\frac{3}{4}$-in. refractor shows this apparently continuous belt broken up into a very remarkable row of detached, or nearly detached, little spots. (*See* Mr. Waugh's Third Report of the Jupiter Section in Vol. III. of the "Memoirs, British Astronomical Association," Plate 1, Figs. 5 and 15.) Both sets of drawings undoubtedly represent what was seen. I observed this apparent belt under both aspects myself. In good seeing the appearance was much as depicted by M. Antoniadi, whilst, when the definition was confused, the little spots ran together so as to form to all appearance a continuous belt of uniform width.

have in order that it may be *perceived*, not necessarily clearly seen. Considerations based on this view of the question might, perhaps, satisfactorily explain why with increase of aperture there might be a tendency to see or draw the lines of a double canal closer together.* I do not, however, quite follow Mr. Goodacre in his argument that with sufficient increase of aperture we should arrive at a point when the two lines will merge in one, for as the breadth of the lines would seem to diminish in much the same proportion as the separation, an almost infinitely great increase of aperture would be necessary for this.† It is rather curious that Prof. Pickering considers the most remarkable duplication ever observed by M. Antoniadi to be real. I allude to his observation of the "lake" Trivium Charontis as two round black spots separated by about 1″.‡

With much of what Mr. Holmes says in his paper ("Journal," p. 300), I am quite in agreement, particularly with regard to what he says as to the influence produced by the presence of cloud on the planet. I have long held the belief that not only is cloud (usually in all probability of a misty or cirrus nature, not entirely masking the surface markings) very commonly present on Mars, but that many of the observed changes—the "inundations" of continents, shifts in position, and variations in visibility or duplicity of the canals, and other markings, and even the apparition of temporary fictitious canals—are due, in a great many cases at least, to comparatively slight changes of contrast caused by the

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* But is there really a proved tendency this way? In two drawings of Mars, by Schiaparelli, reproduced on p. 89 of Vol. I. of the "Journal, British Astronomical Association," and made with the 19-in. refractor of the Milan Observatory, the distance separating the components of the double canals varies from 1″·3 (for Nilokeras) to 0″·2 (for Protonilus). This hardly seems to bear out Prof. Pickering's conclusion that the distance separating the components of the double canals is a function of, or dependent upon, the aperture employed in the manner supposed. I would ask, also: Is it likely, or even conceivable, that an experienced observer like Schiaparelli, using a refractor 19 ins. in aperture of known good quality, could possibly be deceived or in doubt as to the separate existence of two definite and nearly parallel streaks separated by 1″·3 of arc?

† Mr. Goodacre seems to think that the giant telescopes do not show any double canals at all. This, however, is a mistake, as they have been seen with the 30-in. refractor of the Nice Observatory, and with the Lick 36-in. refractor, by several observers, including, it would now seem, from a remark made by Mr. Wesley at a recent meeting, Prof. Barnard. It seems likely that what Prof. Barnard saw was a double canal, as the description accords with what I should suppose would be the appearance of one of the coarser duplications in a big telescope, though the streaks would probably have appeared darker and more definite to my eye under similar conditions. It seems to be an undoubted fact that some observers do see such streaks darker and more definite than others, though the latter are slow to admit the possibility of this. It is obvious that the optical theory utterly fails to account for the fact that one of the streaks observed by Prof. Barnard was longer than the other. There are other similar cases of a like inequality on record.

‡ Prof. Pickering states that he has never seen a canal double himself. He is certainly, however, entered on p. 169 of Vol. I. of the "Annals of the Lowell Observatory" as having seen the Ganges double on November 13, 1894. Probably this is a misprint or error in the Lowell "Annals," though there would seem to have been something peculiar in the appearance of the Ganges to Prof. Pickering, since on several other nights duplicity was suspected by him.

presence or absence of cloud. As Mr. Holmes well puts it, "local fogs or haze would dim or hide both large and small "detail in a very irregular manner."

But astigmatism altogether fails to account for the duplicity of the canals. I have tried twisting and turning the head in various directions, partly revolving the tube of the telescope, and other similar experiments, without producing the slightest difference in the duplicity; whilst on several occasions there have been two double canals visible at the same time and lying at widely different angles, other canals nearly parallel to these and equally plain remaining obstinately single. On one occasion, indeed, in 1894, there were three double canals visible at the same time (*see* "Memoirs, British Astronomical Association," IV., 124) lying in three different directions.

Also, I do not consider it to be by any means demonstrated or demonstrable that Prof. Schiaparelli's drawings and maps are inaccurate or incorrect. I have always found them, on the whole, to be most accurate, more so, in fact, than any others. The late Mr. Green's admirable drawings give by far the best *general* idea of the planet, and on a night with confused definition Mars appears to me wonderfully like Mr. Green's drawings. But on a good night many of the minuter details shown by Schiaparelli come into view, and these considerably modify the general view, or the appearance of what Mr. Holmes terms "the established features."

Correspondence.

What is accountable for the Actinic Properties of Sunlight?

I am provoked into asking the above rather stupid-looking question of the practical Members of our Association on account of the issue of a very elementary experiment attempted by myself during the progress of the Solar Eclipse. It is quite possible that the explanation of my difficulty has been public property for years, and that I myself have got it hidden away amongst my piles of books and papers; at any rate, I cannot find it. Subjoined is an account of the experiment:—

I have got a Wynne's actinometer. It occurred to me yesterday to see if this little instrument would demonstrate the difference between the quantity or quality of actinic light emanating from the uneclipsed sun, and the actinic state of the light at the time of greatest eclipse phase. I accordingly stood in the shade and first gauged the intensity of the light before eclipse had commenced. Thirteen seconds sufficed to tint the sensitised paper to match the comparison section. Clouds were very persistent in their attendance as the phenomenon progressed, but soon after greatest phase had been reached a break enabled me to estimate twice over in quick succession the length of time then required to darken the sensitised paper, and still 13 seconds were all I could fairly allow. I should not have wondered to find something like half a minute required. But that was not found to be so

until after last contact. By then, the sun's altitude having very sensibly decreased, a gradually lengthening time required for exposure was apparent. So that I am tempted to ask: What percentage of actinic light is due to the credit of the photosphere, and how much are we to suppose emanates from the corona? I do not want to be told anything about *visual* light in this connexion.

Possibly the instrument was not sensitive enough for the experiment; or, possibly, if I had held it in direct sunshine, I should have found that, whereas for no eclipse three seconds sufficed, at maximum phase 3·001 seconds were required—but I am very weak in faith.

I find it hard to persuade myself that there ought not to be any perceptible difference experienced in such conditions, but I am doubtful about the value of the evidence afforded by exposing dry plates in a camera for identical intervals of time during the progress of a solar eclipse, because I fail to see how you can be certain of maintaining *absolute uniformity of energy* in your developer.

William Godden.

Notices of the Association.

The last Meeting of the Association for the current Session will be held on Wednesday, June 27, at Sion College. The chair will be taken at 5 o'clock.

The Auditors to examine the Treasurer's Balance Sheet, and the accounts of the Association will be appointed at this Meeting.

Nominations for the Council, for the ensuing Session, in addition to those proposed by the Council must either be made at the Meeting or sent to the Secretaries previous to it, in accordance with Rule V.

Any Member is entitled at or before the June Meeting to propose additions to the names on the list prepared by the Council, and the additional names so proposed will, if the nomination be duly seconded, be added to the Council list.

The following Members of the present Council retire on September 30, in accordance with Rule V., sect. 6, and are not eligible for re-election until after an interval of one year:—Rev. J. M. Bacon, Dr. A. A. Rambaut, Dr. G. Johnstone Stoney, and Mr. W. H. Wesley.

The following papers have been received for reading at the Meeting:—

The Light Streaks in Ptolemaus.—A. STANLEY WILLIAMS, F.R.A.S.

Observations of the Green Ray.—Col. E. E. MARKWICK, F.R.A.S.

Occultation of Saturn by the Moon, June 13, 1900.—Prof. M. MOYE.

Several papers on the recent Eclipse have also been received, and Members of the different Eclipse Expeditions will attend to give an account of their observations of that phenomenon.

Editorial.

The Editor greatly regrets that owing to his preparations for the Eclipse he was not able to see a proof of the cover of the Report of the Photographic Section, upon which by an accident, Mr. Denning's name had been substituted for Mr. Lunt's, as joint Director with Mr. Wilding.

Additions to the Library.

Baxendell.—Meteorological Observations made at Southport, 1899.

Boccardi.—Studio sella variozione della Latitudine di Collurania. Il methodo di Tietjen per la corezione dell'orbita di un pianeta. Applicazione del metodo di Tietjen a Vincentina (366) e Vaticana (416).

Harvard College Observatory Annals. Vol. XXXII., Part 2.
" " " " Vol. XXXIII.
" " " " Vol. XLII., Part 2.

Greenwich Observations in 1897.

Madras Meridian Circle Observations. Vol. IX.

Cape Observatory—Annals. Vol. II., Part 2.
" " Catalogue of 3,007 Stars.
" " " 2,798 Zodiacal Stars.

English Mechanic.—Vol. LXX.

Astronomischen Nachrichten.—Band CLI.

Bulletin Astronomique.—Tome XVI.

Ciel et Terre.—Tome XX.

Savilian Professor of Astronomy.—25th Annual Report.

Clark and Sadler.—The Star Guide.

Toronto.—Astronomical and Physical Society.—Transactions, 1899.

Yerkes Observatory.—Publications, Vol. I.

Hale.—2nd Annual Report of the Yerkes Observatory.

Merfield.—Orbit Elements, Comet, I. 1899.

Harvard College Astronomical Observatory.—Annals, Vol. XLIV., Part 1.

Eclipse de Sol de 1900 Maio 28 em Portugal.

Cortie.—The Total Solar Eclipse of May 28, 1900.

The Library Catalogue (including additions to the end of last Session) will be forwarded by the Hon. Librarian on receipt of 1*s*. 1*d*.

New Members of the Association.

ELECTED 30TH MAY 1900.

DONALD WILLIAM HORNER, F.R.Met.Soc., Milford Lodge, 82, New Park Road, Clapham Park, S.W.

WILLIAM THYNNE LYNN, B.A., F.R.A.S., 21, Bennett Park, Blackheath, S.E.

LOUIS F. OTTO, Assistant Master, Philander Smith Institute, Mussoorie, N.W.P., India.

EBENEZER JAMES SEWELL, Wavendon Manor, Woburn Sands, Bucks.

ARTHUR HOWE STEVENSON, 102, Riggindale Road, Streatham, S.W.

Candidates for Proposal as Members of the Association.

27TH JUNE 1900.

DR. JAMEL LAMBIE,
Lowick, Beal, Northumberland.
Proposer—John Dansken. *Seconder*—John Cassells.

MRS. ADA MARY MASKELYNE,
88, Trinity Road, Upper Tooting, S.W.
Proposer—Nevil Maskelyne. *Seconder*—Jno. M. Bacon.

MISS MARY ELIZABETH WOOLSTON,
High Street, Wellingborough.
Proposer—Nevil Maskelyne. *Seconder*—John M. Bacon.

Victoria Branch, Melbourne.

NEW MEMBERS OF THE ASSOCIATION.

Elected, 5th April 1900.

JOHN N. CAMERON, 3, Flinders Court, Melbourne.

CAPT. W. C. THOMSON, c/o A. C. Macdonald, 31, Queen Street, Melbourne.

Meteoric Section.

The Director wishes to notify that letters should be addressed to him at 100, Egerton Road, Bishopston, Bristol.

The Perseid Meteoric shower may be well observed this year during the last 12 nights of July, as there will be little moonlight. The Director hopes that as many observations as possible will be obtained at this period, as we already possess a large number of observations made in August in various years. What is now urgently required is the observed position of the radiant point on each one of the last 12 nights of July.

Notes.

COMET NOTES.—Giacobini's Comet (a 1900) has been observed on its emergence from the sun's rays, its place agreeing closely with Berberich's ephemeris for Berlin midnight, which is continued below:—

Date.	R.A.	N. Dec.	Date.	R.A.	N. Dec.
	h m s	° ′		h m s	° ′
June 28	23 56 17	40 31	Aug. 3	19 22 21	39 50
July 2	23 36 32	42 31	„ 7	18 57 55	36 39
„ 6	23 12 47	44 21	„ 11	18 37 45	33 21
„ 10	22 44 43	45 51	„ 15	18 21 18	30 7
„ 14	22 12 29	46 51	„ 19	18 8 0	27 1
„ 18	21 37 4	47 7	„ 23	17 57 19	24 9
„ 22	21 0 16	46 31	„ 27	17 48 46	21 30
„ 26	20 24 19	45 0	„ 31	17 41 57	19 5
„ 30	19 51 16	42 42	Sept. 4	17 36 41	16 55

The comet is of about the 10th mag., and will slowly brighten till the middle of July, after which it will fade pretty rapidly.

Mr. C. J. Merfield has computed the orbit of Comet 1899 I. (Swift), using about 100 observations, the dates ranging from March 4 to July 15, 1899. He deduces the following hyperbolic elements:—

	Probable Error.
$T = $ 1899, April 12·977687 G.M.T.	0·000106.
$\omega = 8^\circ\ 41'\ 44''\cdot8$.	$2''\cdot0$.
$\Omega = 24\ 59\ 10\ \cdot9$.	1 ·3.
$i = 146\ 15\ 31\ \cdot1$.	0 ·7.
$q = 0\cdot3265681$.	0·0000014.
$e = 1\cdot000349$.	0·000004.

MINOR PLANET NOTES.—The planet Eros has been detected recently, first at Arequipa, and then by Prof. Howe, some four hours before the total eclipse (not during totality, as was erroneously stated in "Nature" for June 7). The latter observation showed that the ephemeris deduced from Millosevich's elements required the following corrections on May 28 last:—R.A., + $4^s\cdot14$; Dec., + $33''\cdot0$. This shows that Millosevich's value of the mean daily motion is about $0''\cdot1$ too small.

Four new planets have been discovered since the last note was written, as follows:—

Provisional Designation.	Discoverer.	Place.	Date.
FE	Hirayama	Japan	1900, March 6.
FF	Hirayama	Japan	„ March 6.
FG	Wolf-Schwassmann	Heidelberg	„ May 26.
FH	Wolf-Schwassmann	Heidelberg	„ June 4.

The following planets have received permanent numbers :—

Planet.	Discoverer.	Date.	Number.
EX - -	Coddington -	1899, Oct. 4 -	445.
ER - -	Wolf-Schwassmann -	„ Oct. 27 -	446.
ES - -	Wolf-Schwassmann -	„ Oct. 27 -	447.
ET - -	Wolf-Schwassmann -	„ Oct. 27 -	448.
EU - -	Wolf-Schwassmann -	„ Oct. 31 -	449.
EV - -	Wolf-Schwassmann -	„ Oct. 31 -	450.
EY - -	Charlois - - -	„ Dec. 4 -	451.

EN, EP, EQ, EW, EZ proved to be identical with (85) Io, (32) Pomona, (161) Athor, (110) Lydia, (415) respectively. EO does not receive a permanent number, not having been sufficiently observed.

Oxford University Observatory.—Prof. H. H. Turner, in the 25th Annual Report, reviews the history of the Observatory sanctioned by the University in 1873, and completed in 1875. The energies of the staff are now directed to pushing forward the work for the Astrographic Catalogue. Out of 1,180 plates to be taken 736 are now measured, and 705 completely reduced. One or two more years will be required, but the work is as well advanced as in any of the 18 other observatories engaged. Measurements have been made on a large plate supplied by Prof. E. C. Pickering to determine the optical distortion of a photographic doublet. A preliminary reduction indicates a distortion varying as the cube of the distance from the centre of the plate; it is hoped that it will be possible to make reductions of these wide-angle star fields with great accuracy. (Nat., May 31.)

Astronomical Publications.

A Very Ancient Eclipse. *W. T. Lynn.*—It has occurred to Prof. Stockwell that the "horror of great darkness" that fell upon Abraham "when the sun was going down" (Gen. XV., 12) might have been caused by an eclipse, and he has recently found that the annular eclipse of July, 13 B.C. 1927, very completely tallies with the description, since it passed almost centrally over Jerusalem at about 3 o'clock in the afternoon. The date of this event in the life of Abraham may have been about that of the eclipse calculated by Prof. Stockwell, but we cannot claim more than a measure of probability for it, especially under our uncertainty of the cause of the patriarch's "horror." (Obs., May.)

The Eclipse of Josephus. *W. T. Lynn.* — The years B.C. 1, B.C. 2, and B.C. 4, have been adopted by various authorities for the eclipse of the moon mentioned by Josephus as preceding the death of Herod, but all are open to objections.

The only one that appears to fulfil the conditions is that of September 15, B.C. 5, for its middle fell at Jerusalem at 9.45 in the evening, and the date was probably about six months before the death of Herod. If we accept it, we are bound, of course, to conclude that the Nativity of Christ took place much earlier in the year than the traditional time of Christmas Day. (Obs., June.)

ARTIFICIAL "RESEAU PHOTOSPHERIQUE." *Rev. A. East.*—By floating granules of the curd of milk in a saturated solution of salt and water a representation of the granulation of the solar surface is obtained. If the pan containing the solution be placed upon a hot plate almost immediately spherical masses of the granules begin to rise, and when these masses meet they mutually compress each other, the lines of impact being mostly straight, thus we get a very regular "reseau." It is suggested that here we have an explanation of the solar reticulations. Masses of the heated lowest strata of the sun must of necessity rise, become relatively cool, extend themselves and sink again. The rising masses of heated photospheric material are normally spherical, and the rectilinear arrangement forming the "reseau" is the result of the mutual pressure of the masses. If these artificial granules truly represent the behaviour of the solar granules it is evident that the conditions on the sun when spots are formed are exactly the opposite of those when reticulations are fashioned, the former depending upon the compactness, the latter on the diffusiveness of the photospheric materials. It is pointed out that it appears to be generally considered that the solar energy is at a maximum during the sunspot maximum, but the exact opposite may be nearer the truth, the appearance of spots heralding the reviving solar fury which has not reached its height until the sun's outer garment has been rent to shreds and the sunspot minimum has arrived. (Kn., June 1900.)

THE NATURE OF THE SOLAR CORONA. *Geo. Fras. FitzGerald.*—There is every reason to think that the corona line is not represented in the solar spectrum. In "Annalen der Physik" for March, page 462, Herr Cantor describes experiments, from which he concludes that there is no absorption corresponding to the light emitted by a gas caused to radiate by an electric discharge. This confirms the suggestion that the corona is due to an emission of a similar character to that of a gas transmitting an electric discharge. (Nat., May 3.)

ASTRONOMY WITHOUT A TELESCOPE. IV. A TOTAL SOLAR ECLIPSE. *E. Walter Maunder.*—The wide field of work which is open to eclipse observers, who are unequipped with instrumental aid, is dealt with in this paper. First, comes sketching the corona, and many valuable suggestions for the accomplishment of this are given, stress being laid on the importance of frequent practice beforehand. The search for stars and the zodiacal light is another class of work, and a record of the appearance of the latter, if it could be obtained, would be of the utmost value. Observations of the shadow bands, meteorological observations, the approach of the lunar shadow, and many other eclipse

phenomena are all fully dealt with, and, although almost outside the category, suggestions for the use of ordinary cameras for photographing the landscape during totality and recording the increase in darkness as the eclipse comes on, are included. (Kn., May, 1900.)

ASTRONOMY WITHOUT A TELESCOPE. V. OBSERVATIONS OF THE SUN. *E. Walter Maunder*.—This is a suggestive paper pointing out how useful observations of the sun's path in the heavens can be made by the aid of the simplest instruments. The determination of the meridian, the solstices, the equinoxes, the obliquity of the ecliptic, &c., could all be made, the exactness of the determinations depending upon the skill and patience of the observer. (Kn., June 1900.)

THE TOTAL ECLIPSE OF 1900, MAY 28. *Prof. W. H. Pickering* thinks that direct photographs of the corona have little scientific value, and drawing still less. In case observers wish to obtain photographs as souvenirs, he recommends a telescope of not more than three inches diameter, and a slow plate giving great contrast. For the outermost regions of the corona a lens of only a few inches focus should be used. In 1886 the corona was traced for 90° degrees from the limb with a lens of 8½-in. focus, though detail ceased at 60°. Probably the most useful observation that could be made by the average person would be that of the duration of totality. The blackness of the moon in comparison with the sky is shown by photography to be a real phenomenon. It indicates that the general illumination of the sky round the corona is due to a source of light beyond the moon; it is due to the reflection of the sun's light from countless small bodies revolving about and lying chiefly inside the earth's orbit. (P.A., May.)

THE DARK FRINGES OBSERVED DURING TOTAL SOLAR ECLIPSE. *Señor V. Ventosa*, of the Madrid Observatory, has studied the currents in the upper regions of the atmosphere, and agrees with those who attribute the "shadow bands" to their action. An experimental illustration may be produced by reflecting light from corrugated glass through a circular aperture, representing the sun, over which an opaque moon is made to slide. When the uncovered segment has a width of about 5 mm., bands may be seen on a screen held near if the segment is parallel to the undulations of the glass; if these directions are at right angles the bands disappear. He urges that records should be made of the direction and velocity of the wind during eclipses, in order to give more definite data for discussion. (Nat., May 24.)

PHOTOMETRY OF CORONA, 1893, APRIL 16. *Prof. H. H. Turner, F.R.S.*, in a recent communication to the Royal Society, describes measures of plates taken by Sergeant Kearney at Fundium. Parts of each plate used had previously received in the laboratory a graduated series of exposures to a standard light. These parts were protected during the eclipse, and the whole plate was developed at one time. Prof. Turner finds that the method gives very accurate determinations, that the law of diminution of

light was nearly the same in four directions, N., S., E., and W., but that there was a marked difference in the intensities along the N. and S. radii; the diminution, at first very rapid, was very gradual at more than 45° from the limb. The absolute brightness is given in terms of the "Moon," and agrees closely with that determined visually by Sir W. Abney and Prof. T. E. Thorpe. No visual measures were made within 0·6 of a radius from the limb, and it is suggested that such should be taken on May 28. (**Nat.**, May 24.)

SEARCH FOR AN INTRAMERCURIAL PLANET. *W. F. Denning.* — Should an intramercurial planet exist it must be too small to be distinguished in transit, or it would certainly have been discovered long ago, unless the inclination of its orbit enables it to pass N. or S. of the sun's disk at its conjunctions, which is highly improbable. Having made some thousands of solar observations with a view to the detection of such a planet, the writer has occasionally seen a suspicious looking object, but on closer inspection it has always turned out to be a sunspot. (**Kn.**, June 1900.)

ATTEMPT TO DETERMINE THE DURATION OF THE ROTATION OF VENUS SPECTROSCOPICALLY.—Herr Belopolsky made between March 25 and May 13 a series of observations with a view to determine the vexed question of the velocity of rotation of Venus by means of the displacements of its spectral lines on opposite sides of the disk; a method which would seem to be the more hopeful from the fact that, as the planet shines with reflected light, the relative displacement would correspond to double the velocity of rotation, and at full illumination the velocity corresponding to the relative displacement of the spectral lines on the opposite limbs of Venus would be four times the true velocity.

The result to which the observations point is that the rotation of Venus is accomplished in about a day, or nearly the same time as the earth's. But as the appliances of the instrument used (a two prism spectrograph and one provided with three compound prisms mounted on the 30-inch refractor at Pulkowa) were not specially adapted to this species of observation, Herr Belopolsky regards the above as only an experiment to determine the true duration of rotation of Venus, and suggests that it should be repeated with the aid of the powerful instruments at the Potsdam, the Lick, and the Yerkes observatories, the results of which would probably be decisive. (**Ast. Nach.**, No. 3,641.)

PHOTOGRAPHIC OBSERVATION OF EROS.—Prof. Howe, of Denver Observatory, U.S.A., is said (**Nat.**, June) to have photographed the planet during the recent eclipse. This is a mistake; it was four hours before the eclipse that the photograph was taken. The position found was:—

$$\alpha = 23 \text{ h. } 47 \text{ m. } 3{\cdot}9 \text{ s.}, \ \delta = +\ 2^\circ\ 46'\ 33''$$

for 1900, May 27·9129 G.M.T.

THE SATELLITE OF NEPTUNE.—M. Kostinsky, of Pulkowa, in February and March 1899, made some photographic observations of the satellite of Neptune, and has recently published a paper containing the angles of position and distances from the planet, together with the differences between the results and those

derived from the ephemeris of the satellite which were computed from the elements of Herr H. Struve, and inserted in the "Connaissance des Temps for 1899." M. Kostinsky had already made some similar observations of one (Deimos) of the satellites of Mars, and remarks that those of the satellite of Neptune were easier on account of the feebler light of the planet and the slower motion of the satellite. He refers to those made at the Royal Observatory, Greenwich, about the same time ("Monthly Notices," Vol. LIX., p. 501) by a special method, shutting off the light of the planet during the greater part of the long exposure, and somewhat criticises this method as possibly introducing errors into the results obtained which may be not merely accidental, but systematic. Nevertheless, they agree fairly well with his own, and appear to indicate that the elements of the satellite's orbit require some small corrections. (**Ast. Nach.**, No. 3642.)

PHOTOGRAPHS OF THE NEBULÆ M. 8, SAGITTARII, AND H VI. CETI. *Isaac Robert.*—Two photographs taken with the 20-in. reflector. The first shows a nebula in apparently an early date prior to a spiral formation, the second a spiral viewed at an acute angle. (**Kn.**, June 1900.)

THE UNKNOWN IN ASTRONOMICAL SPECTROSCOPY. *A. Fowler.*—The gradual disappearance of the "unknown lines," which there had been a tendency to regard as indicative of the presence of non-terrestrial matter in some of the heavenly bodies, has been effected by work along five principal routes:—

(1.) The search for elements not previously known to exist upon the earth.
(2.) The more exact determination of the wave-lengths of lines, both terrestrial and celestial.
(3.) The discovery of additional spectra of well-known substances.
(4.) The application of the laws of spectrum series.
(5.) The investigation of enhanced lines.

In spite of the progress of recent years, we are still in ignorance of the chemical significance of several lines of great importance. Chief among these are lines which occur in the spectra of nebulæ, those in the spectrum of the solar corona, and certain lines which appear in the spectra of the Wolf-Rayet stars. It seems by no means too much to expect, however, that work along the various lines indicated will ultimately result in the complete elimination of the so-called "unknown elements" from celestial chemistry. (**Obs.**, May.)

ESCAPE OF GASES FROM PLANETARY ATMOSPHERES. *S. R. Cook.*—Dr. Stoney (**Nat.**, March 29) questioned the validity of assuming Maxwell's distribution of velocities in computing the escape of gases, as this does not hold at the attenuated limits. Mr. Cook replies that there can be no doubt that it holds at a height of 20 kilometres, and that if we assume the atmosphere to stop abruptly there—a condition in which the escape would be much greater than it actually is—an atmosphere consisting entirely of helium would lose only $26 \cdot 73 \times 10^{-23}$ c.c. in 10^7 years. One of hydrogen would lose $0 \cdot 54$ c.c. in one year. These figures

show that neither gas can be escaping in large quantities from our atmosphere. (**Nat.**, May 17.)

Dr. Johnstone Stoney replies that our knowledge of molecular physics is too limited to furnish a valid investigation. His reasons will be developed more fully in **Ap. J.** for May and June, but the principal causes of error he believes to be in the neglect of two terms which, though negligible under ordinary conditions, may become sensible at the limits of the atmosphere, and in overlooking the fact that Maxwell's law holds good only for a portion of an isotropic gas, surrounded by similar gas. He believes it to be safer to ascertain from observed facts what escape has taken place. Argon and helium are being supplied to the atmosphere, the former by all hot springs which contain atmospheric gases, the latter by some of them. Considerations are adduced which show that the argon has been previously absorbed from the atmosphere whilst the helium is derived from mineral sources. The exceedingly small quantity of helium found in the atmosphere, 10^{-6} of the whole volume, shows that it must be escaping at a rate practically equal to that of influx; whilst similar considerations show that argon is unable to escape. Water vapour bears nearly the same dynamical relation to Mars that helium does to the earth; hence it is concluded that water cannot remain on Mars, and that the polar caps are probably carbon dioxide. (**Nat.**, May 24.)

Prof. G. H. Bryan, F.R.S., in a paper communicated to the Royal Society on April 5, examined the same question, assuming the Boltzmann-Maxwell distribution, and taking account of the axial rotation as well as of the attraction of the planet. He concluded that helium would be permanently retained by the earth, and water vapour by Mars. The distribution assumed implies an atmosphere of uniform temperature throughout. The modifications required by the actual temperature conditions will be considered in a further paper, but it will scarcely be maintained that lowering the temperature of the upper regions will facilitate the escape of helium. Arguments are given to show that if helium does escape from our atmosphere, either there is some fallacy in the fundamental assumptions underlying much of what has been written on the kinetic theory, or else our notions of the close physical relation between temperature and kinetic energy are at fault. The escape of gases from planetary atmosphere depends very directly on the translational kinetic energy, and furnishes means for testing this relation. If the methods of the kinetic theory should prove inapplicable to very rare as well as to very dense assemblages of molecules, and do not altogether agree with experiment for intermediate densities the position is serious, and calculations should not be abandoned, but should be pressed to their utmost limit in order to bring out the true bearing of the facts. (**Nat.**, June 7.)

The Spectra of Algol Variables. *W. H. S. Monck.*—Assuming the usual theory of Algol variables as double stars, and the nebular theory of their evolution, Algol ought to be rotating very rapidly in the same direction that the satellite revolves round it, and the lines of its spectrum ought to be broad, because one side is moving towards us while the other is moving away. But

when the eclipse commences, the satellite will first blot out the side whose motion is towards us; the lines of the spectrum will accordingly become narrower, and will indicate receding motion. After the minimum this will be reversed, and the lines will indicate approaching motion. At the crisis of the eclipse the satellite is nearest to us and Algol itself farthest; consequently, Algol must have been receding before the minimum, and approaching after it, and this is established by spectroscopic observations. But the considerations urged above may suggest that the *rate* of recess and approach has been over-estimated. (**Obs.**, June.)

Minima of the Variable Stars of the Algol Type.

(Given to the nearest hour G.M.T.) (P.A., 213 and 286.)

U Cephei.

	d	h
May	4	13
„	9	12
„	14	12
„	19	12
„	24	11
„	29	11
June	3	11
„	5	22
„	8	10
„	10	22
„	13	10
„	15	22
„	18	10
„	20	21
„	23	9
„	25	21
„	28	9
„	30	21

S Velorum.

	d	h
May	11	17
„	17	15
„	23	14
„	29	12

δ Libræ.

	d	h
May	1	20
„	6	12
„	8	20
„	13	11
„	15	19
„	20	11
„	22	19
„	27	11
„	29	18
June	3	10
„	5	18
„	10	10
„	12	18
„	17	9
„	19	17
„	24	9
„	26	17

U Ophiuchi.

Every 10th Min.

$P = 20^h \cdot 13$

	d	h
May	8	10
„	16	20
„	25	5
June	2	14
„	10	23
„	19	9
„	27	18

U Coronæ.

	d	h
May	2	14
„	9	11
„	12	22
„	16	9
„	19	20
„	26	18
June	9	13
„	13	0
„	16	11
„	19	22
„	23	9
„	26	19

$+12°3557$.

	d	h
May	1	22
„	2	20
„	3	17
„	4	14
„	5	11
„	9	22
„	10	20
„	11	17
„	12	14
„	13	12
„	17	22
„	18	20
„	19	17
„	20	14
„	21	12
„	25	22
„	26	20
„	27	17
„	28	14
„	29	12

Z Herculis.

Even epochs.

	d	h
May	2	16
„	6	15
„	10	15
„	14	15
„	18	14
„	22	14
„	26	14
„	30	14

Odd epochs.

	d	h
May	4	15
„	8	15
„	12	15
„	16	15
„	20	14
„	24	14
„	28	14

$+45°3062$.

	d	h
May	3	17
„	8	7
„	12	21
„	17	10
„	22	0
„	26	14
„	31	4
June	4	17
„	9	7
„	13	21
„	18	11
„	23	0
„	27	14

W Delphini.

	d	h
May	5	21
„	10	16
„	29	22
June	3	17
„	8	13
„	13	8
„	22	23
„	27	18

Y Cygni.

Even epochs.

	d	h
May	3	16
„	6	16
„	9	16
„	12	16
„	15	16
„	18	15
„	21	15
„	24	15
„	27	15
„	30	15

Even minima.

June	2	15
July	2	14

$2P = 2^d\ 23^h \cdot 9^h$

Odd epochs.

May	1	18
„	4	18
„	7	18
„	10	18
„	13	18
„	16	18
„	19	18
„	22	18
„	25	18
„	28	18

Odd minima.

May	31	18
June	30	17

$2P = 2^d\ 23^h \cdot 9$

S Cancri.

	d	h
June	9	2
„	18	14
„	28	1

Maxima and Minima of Long Period Variables (P.A., 212).

May and June 1900.

MAXIMA.

Star.	Mag.	Day.	Star.	Mag.	Day.
MAY.			JUNE.		
U Piscium	9·7	9	*U Sculptoris*	8·7	5
U Persei	7·7	29	*U Ceti*	7·1	10
R Arietis	8·3	18	*X Ceti*	9·3	30
R Fornacis	8·5	18	*R Columbæ*	7·9	17
V Aurigæ	9·2	8	*R Geminorum*	7·2	10
V Monocerotis	6·6	21	*S Canis Minoris*	7·6	6
S Lyncis	9	4	*S Geminorum*	8·5	15
R Leonis	6·0	5	*V Cancri*	7·3	9
T Virginis	8·4	11	*— Hydræ*	8·5	1
RS Libræ	8	28	*R Ursæ Majoris*	7·1	9
W Libræ	9·8	26	*T Canum Venat.*	8·7	13
R Herculis	8·6	6	*U Virginis*	7·9	27
S Ophiuchi	8·7	20	*T Centauri*	5·9	7
RV Herculis	9·3	21	*T Libræ*	9·7	26
— Aquilæ	9	28	*S Serpentis*	8·2	13
W Capricorni	10·6	22	*X Libræ*	9·7	28
Y Aquarii	8·8	25	*V Ophiuchi*	7·3	3
U Capricorni	10·5	10	*R Sagittarii*	7·5	9
V Capricorni	9	6	*T Sagittæ*	8·5	16
T Capricorni	9·3	10	*χ Cygni*	5·3	13
Y Capricorni	10	6	*Z Aquilæ*	8·9	26
S Piscis Australis	9·0	16	*R Microscopii*	8·0	5
R Lacertæ	8·8	13	*X Capricorni*	10·0	3
V Ceti	9·0	19	*SS Cygni*	8·5	11 ?
			V Pegasi	8·2	23
JUNE.			*S Lacertæ*	7·7	21
S Sculptoris	6·5	15	*W Pegasi*	8·1	17
T Cassiopeiæ	7·5	27	*— Cassiopeiæ*	9·4	16
V Andromedæ	8·7	13			

MINIMA.

MAY.			JUNE.		
R Andromedæ	<12·8	18	*W Cassiopeiæ*	11·4	23
R Piscium	<13	16	*T Camelopardalis*	<12	18
R Ceti	13·5	9	*S Libræ*	<13	26
R Canis Minoris	9·7	15	*R Draconis*	12·5	29
R Virginis	9·8	17	*T Herculis*	10·7	18
S Ursæ Majoris	10·8	18	*R Vulpeculæ*	13	15
S Bootis	12·8	24			
R Bootis	11·8	20			
T Draconis	11·7	17			
V Lyræ	12	11			
V Cephei	6·9	6			

1900, July. (**P.A.**, 286.)

Day.	Star.	Day.	Star.
	MAXIMA.	25	*R Capricorni.*
3	*RT Cygni.*	25	*R Virginis.*
4	*S Virginis.*	27	*S Pegasi.*
5	*T Columbæ.*	28	*W Ophiuchi.*
5	*V Geminorum.*	30	*X Aquarii.*
5	*T Pegasi.*	31	*o Ceti* (*Mira*).
6	*U Bootis.*	31	*R Comæ.*
9	*V Cassiopeiæ.*		
10	*S Leonis.*		MINIMA.
12	*V Libræ.*	8	*Z Ophiuchi.*
13	*U Lyræ.*	9	*V Bootis.*
16	*Z Virginis.*	11	*W Monocerotis.*
17	*W Lyræ.*	11	*S Sagittarii.*
18	*S Aquarii.*	14	*R Persei.*
18	*R Ceti.*	19	*S Cephei.*
20	*U Cassiopeiæ.*	20	*T Cephei.*
20	*Z Aquarii.*	28	*S Arietis.*
20	*RR Cygni.*	29	— *Pegasi* ($\alpha = 21^h\ 16^m\ 15^s$, $\delta = +14^\circ\ 1'\cdot6$, 1900).
22	*S Ursæ Min.*		
24	*Y Virginis.*		

S Bootis passed a maximum, 7·7 m., March 26, the brightest maximum observed during the last ten years at the Rousden Observatory. (**E.M.**, 291.)

R Camelopardi passed a maximum of $6\cdot9^m$ on March 1. $M - M = 303^d$. (**E.M.**, 185.)

R Draconis reached a maximum of $7\cdot0^m$ on March 1. $M - M = 256^d$. (**E.M.**, 185.)

S Ursæ Majoris passed a maximum of $7\cdot4^m$ on February 20. $M - M = 215^d$. (**E.M.**, 185.)

T Ursæ Majoris has shown a well-marked double maximum, rising to 6·3 m. on March 1, and, after falling to 6·9 m. on March 12, again rising to 6·3 m. on April 5. On April 26, it was 7·9 m. (**E.M.**, 291.)

Anderson's New Variables.—In Andromeda, R.A., $0^h\ 8\cdot5^m$, Decl. + 46° 12′ (1855). Magnitudes, January 16, 8·8; January 19, 8·7; February 20, 9·0; March 14, 9·5. (**A.N.**, No. 3632.) In Taurus, R.A., $5^h\ 44\cdot1^m$, Decl. + 15° 45′ (1855). Its magnitude on March 26 was 9·7, whereas on the previous November 8 it was < 11. (**A.N.**, No. 3634.) In Draco, R.A., $17^h\ 55\cdot6^m$, Decl. + 54° 51′ (1855); $56^h\ 28\cdot6^m$, + 54° 50′ (1900). Its magnitude was, on November 14, 9·4; January 7, 10·2; January 26, 10·4. (**A.N.**, No. 3618.) In Cassiopeiæ, R.A., $23^h\ 48\cdot4^m$, Decl. + 52° 55′ (1855). Its magnitude on February 14 was 9·6; on March 17 and 25, < 10·5. (**A.N.**, No. 3634.)

Prof. E. C. Pickering brings together the results obtained from a study of the Moscow and Harvard photographs of the region in the neighbourhood of Mdme. Ceraski's second Algol Variable, the position of which for 1900 is R.A., $19^h\ 42\cdot7^m$, Decl. + 32° 28′. (**A.P.**, 165.)

Vol. XXXIII. of the Annals of Harvard College Observatory contains three series of observations of variables by Argelander, Schönfield, and Schmidt.

The Total Solar Eclipse.

No report from the American party of the Association had been received at the date of the Meeting on May 30; but the following extracts from an account by Miss Gertrude Bacon, received since, will be of interest.

"Great was the general rejoicing when the dawn of the 28th broke clear and cloudless, and before the day was half an hour old the astronomers were at their respective stations. 'First contact' was at about half-past seven.

"Slowly and impressively the gloom gathered. Towards the end of the first partial phase the darkness came on by leaps and bounds, though to those not actually watching the sun the exact moment of totality was hard to determine; the great cone of blackness sweeping across the sky, sometimes so specially apparent, being hardly, if at all, noticeable on this occasion. At no time, even at mid totality, was the darkness excessive. It was easily possible to distinguish the second hand of a watch, for example. Doubtless this eclipse will stand in future as one of the lightest on record.

"Immediately upon totality the corona flashed out upon the purple-blue sky as an object of indescribable grandeur and beauty. A big black ball represented the eclipsed sun, and round its edge the solar prominences glowed as glorious red jewels. A halo of pearly light encircled the whole, and stretching outwards from this to several times the sun's diameter across the sky to where Venus, Mercury, and a few stars twinkled, spread a number of irregular lateral rays or streamers, forming the 'outer extensions' of the corona.

"As far as can yet be ascertained—for many photographs still await development—a great photographic success will have been scored. The giant instruments worked well, and almost every member of the various expeditions has reason to suppose that he or she has obtained good results. Mr. Nevil Maskelyne, who arrived in America only to discover that his special instrument, a cinematograph of his own construction, had been left behind in England, contrived, with incredible labour, to replace the missing apparatus with an efficient successor.

"A very noteworthy phenomenon witnessed at this morning's eclipse was the extremely rapid return of the light after totality was past. It seemed quite indisputable that the light returned with vastly greater speed than it had previously faded, and the reason for this at present unexplainable fact will afford matter for future investigation."—*Daily Mail*, June 9.

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REPORT OF THE MEETING OF THE ASSOCIATION, HELD ON JUNE 27, 1900, AT SION COLLEGE, VICTORIA EMBANKMENT.

W. H. MAW, F.R.A.S., *President*, in the Chair.

A. C. D. CROMMELIN, B.A., F.R.A.S., *Secretary*.

The *Secretary* read the Minutes of the last Ordinary Meeting, which were confirmed.

The list of presents received was read, and one item, to which the President made special allusion, was a very handsome volume which Mr. W. E. Wilson had sent, describing his great variety of physical work at the Daramona Observatory.

The names of nine candidates for admission were read and passed for suspension, and the election by the Council of three new Members was confirmed. In accordance with the rules of the Association, the ballot list of those nominated as Members of the Council was read to the meeting, and an addition having been made thereto, the President announced the closing of the list. Messrs. Holmes, Tappenden, and Vezey were nominated by the President as Scrutineers of the Ballot, and Messrs. Gordon W. Miller and Henry Ellis were elected to audit the accounts of the Association for the past session.

The *President* said the Members present would be pleased to know that they had with them that evening Mr. Ambrose Swasey, who, although this was the first meeting he had been able to attend, had been a Member of the Association for a considerable time past. Mr. Swasey had been paying a visit to Paris, and had kindly consented to give the meeting a few facts relating to the great telescope there, which he had had an exceptional opportunity of examining.

Mr. Swasey said he was very much gratified to have the pleasure of meeting with his fellow members of the Society. He had been in the Orient, and on his way back to the States had visited Paris, and seen the large siderostat at the Exposition. In company with members of the Jury of Awards, he visited the great instrument, which was fully explained to them by M. Gautier, the constructor. From an engineering and mechanical standpoint, the instrument appeared to have been admirably designed, and of excellent workmanship. The great reflecting mirror is so well mounted and so perfectly balanced, and the friction of the sliding and revolving parts so reduced to a minimum, that it can be moved to any position with the greatest ease. All the quick and slow motions, together with the reading of the fine circles, are so arranged as to be readily accessible to the assistant. M. Gautier seems to have given most careful study to every detail, not only of the mounting for the mirror, but also to the telescope throughout. As to the optical parts, the mirror and the photographic lenses are now in place; but it is understood that they are not yet fully perfected, owing to lack of time. The discs for the photographic and visual objectives were made by M. Mantois, and although the discs for the latter have not yet been figured, they are said to be of most excellent quality.

Mr. Swasey added that he hoped that M. Gautier, in the completion of the optical parts, would prove himself as able an optician as he is an engineer, in which case the great siderostat will become a valuable aid to the cause of science.

The *President* said the chief business of the evening was to receive the reports of the eclipse observers; but before any of the papers were read, or any observations reported, he would call upon Mr. Maunder, who had a vote of thanks to propose to the authorities in the various countries who had aided so much in making this series of observations a success.

Mr. Maunder, who was received with applause, said that a large number of Members of the Association had been away from home visiting different countries upon the occasion of the recent eclipse. To view the previous eclipse they had gone to a country which was British, and they were not, in that sense, away from home; but although on the recent occasion they had travelled to four different foreign countries, there was but one opinion amongst the observers, and that was that they had been extremely well treated by the authorities and astronomers of the countries which they had visited. It therefore seemed to him that it was their first duty, as a simple matter of justice, as well as of gratitude, to record their sense of the courtesy and assistance which had been extended to them; he had, therefore, great pleasure in proposing the following resolution:—"That this "meeting of the British Astronomical Association desires to "record its sincere appreciation of the ready courtesy and "valuable assistance rendered to the Members of the various "expeditions in the observation of the total solar eclipse of "1900, May 28, in the United States, Portugal, Spain, and "Algeria." He believed some of the Members who had been to

the various countries would like to speak more definitely as to the different persons to whom they were severally and individually indebted.

Dr. Downing said he seconded the motion with great pleasure. He really found it difficult to speak in sufficiently strong terms of the courtesy and of the hospitality with which the Members of his party were received in Spain. He desired to mention the names of those who were chiefly responsible for the comfort of the party. In the first place he would mention Señor Iniguez, the Director of the Madrid Observatory. The British party, with which he (the speaker) was connected, took up its position next door to the Spanish party, and they found this to be of great assistance, because it enabled them to have a reserve ground kept which the Spanish astronomers had secured for the occasion; and also to have a detachment of the civil guard on the spot to keep off the "madding crowd," so that they could pursue their observations without molestation. Then he desired to mention the Marquis de Mirabel, a Spanish nobleman, who had a palace in Plasencia, where the observers were stationed, and also a palace in Madrid. At the time of the eclipse, the Marquis was resident in Madrid; but as soon as he heard that Mrs. Downing was to accompany him (the speaker) to Plasencia, he, with the greatest hospitality and courtesy, offered to place his palace in Plasencia at their disposal, as he realised that there were no hotels or inns in the town fit for a lady to go to. The Marquis conveyed a message to him, through Señor Iniguez, to that effect, and they very gladly accepted his hospitality. They owed him, indeed, their most grateful thanks for the comfortable and pleasant way in which they were able to spend their time in Plasencia. He also ought to mention the Governor of Caceres, the district in which Plasencia was situated, who came over for the day and was most polite to the party, making everything easy for them so far as it was in his power to do.

Mr. Crommelin said he could re-echo, with regard to Algeria, what had been said by Dr. Downing as to the kindness with which the Spanish expedition was treated. The Members who went to Algeria had no land journey to make when they got there; the steamer took them actually to their eclipse station, and that, of course, greatly facilitated matters. The Customs authorities everywhere let them through very easily indeed, and that was a matter that called for gratitude, considering what trouble such authorities could cause sometimes. They also found M. Trépied and the staff at the Algiers Observatory most kind, and ready to help in every way when asked for their assistance. They extended hospitality directly to a great many observers; but, of course, the British Astronomical expedition was not stationed there. They helped the expedition, however, in getting the time and in other little ways. The manager of the Hôtel de la Régence, at which they stayed, also deserved their thanks, for he gave them the free use of the roof of the hotel, keeping it quite private, and not allowing any other observers up there. In every way possible he helped them in making their observations.

A 2

Mr. G. F. Chambers said that the remarks which had been made by Dr. Downing and Mr. Crommelin applied exactly to the circumstances of Portugal; yet, if anything, they understated the kindness shown and the facilities offered to the British astronomers who went to that country. Great preparations had been made by M. Marianno Carvalho, the late Minister of Finance in the Portuguese Government, in the organisation of various facilities for the reception of English astronomers, and that gentleman was well backed up by Capt. Perrin, of the Royal Artillery, and also by M. Rodrigues, the director of the Lisbon Observatory. Among the facilities which he (the speaker) and some other astronomers were granted were free railway tickets for traversing the whole of Portugal, of which he made full use by travelling everywhere he could in the time available. As he was staying with private friends at Oporto, he only had occasion to go to Ovar for the day to view the eclipse. He and his friends were guarded at Ovar by cavalry and police stationed to keep off the crowd. This was not by any means an unnecessary precaution at Ovar, for the royal princes had decided to go thither, and a great crowd naturally assembled. Not only were facilities of various kinds provided by the Portuguese Government, but also by various public and private bodies in the country; and he was the more struck by this because he had heard that England was exceedingly unpopular in Portugal, in consequence of recent events in South Africa. During the whole of his sojourn in Portugal he did not come across, either publicly or privately, the slightest indication of there being any unfriendly feeling on the part of the Portuguese public, of any rank whatever, towards England or the English people who assembled there. He believed the outcry was purely one trumped up by the low Radical newspapers of Portugal, and that the people at large quite reciprocated the friendly feeling which had existed between Portugal and England for the last two centuries. Portugal, on the occasion under notice, had certainly behaved most handsomely towards the English astronomers who went out to see the recent eclipse.

The resolution was carried unanimously.

Several Members then spoke as to the observations made by them of the recent solar eclipse.

Dr. Downing said his party took up their position at Plasencia, about 140 miles S.W. of Madrid, and consisted of Sir Howard Grubb and his son, Dr. Rambaut, Prof. Joly, Mr. Wilson, Mr. Geoghegan, Mr. Burgon, Mrs. Downing, and himself. Sir Howard Grubb and Dr. Rambaut had a prismatic camera at work for taking a series of photographs of the spectrum of the corona, including the flash at either end. Prof. Joly had a cœlostat arrangement for taking direct photographs of the corona; and Mr. Wilson had a similar arrangement, provided with a yellow screen, for taking photographs of the corona in monochromatic light. He (the speaker) had an opera-glass, with spectroscope fitted by Mr. Thorp. This acted most satisfactorily, surpassing his expectations. Mr. Thorp had fitted a grating to one of the object-glasses of the binocular, by which he (Dr. Downing) could

observe the spectrum, and through the other tube of the binocular he was able to observe the corona directly. The rather unpleasant and responsible duty of giving the signal to the photographers when to commence making their exposures, and when to cease doing so, was assigned to him. However, he managed to do it to the satisfaction, he believed, of everybody. It was very difficult to hit on the exact instant of the commencement of totality; but in giving the signal he did not think he lost the observers more than a fraction of a second. At the end of totality it was comparatively easy to give the signal at the right time. His own observation consisted in examining the distribution of coronium with the spectroscopic arrangement, and comparing it with the extensions of the corona viewed directly through the other tube of the binocular. He observed that the coronium arc was much broader and more diffused than the neighbouring arcs of magnesium and helium which were visible in the spectroscope at the same time. He estimated the average breadth of the coronium arc to be about one-eighth of the diameter; but at a special part it was very much wider, being about one-fifth of the diameter approximately. This part corresponded to the position angle of about 270°, and that would tend to show that this additional amount of coronium was present in the corona near the base of the large extension on the western limb of the sun. According to his observation, therefore, the general height of coronium in the corona on this occasion was a little over 100,000 miles; but at this special part, near the base of this branch of the corona, it extended to about 180,000 miles. Mr. Geoghegan kindly undertook to look for shadow bands. They had provided themselves with a large sheet which they spread on the ground, and four sticks, by means of which they were to indicate the direction in which the bands lay, and also the direction in which they were moving, both before and after totality. Nothing was seen of the bands until about two minutes before totality. Mr. Geoghegan was then able to see them, and, according to the positions assigned by him, he (the speaker) found, by compass, that the direction in which the bands lay before totality was about 10° N. of E. magnetic, and that they were moving sensibly in a direction at right angles to that in which they lay. They were seen just after totality was over, and up to about two minutes after totality ended. The direction had then backed a little, being N.E., and they were still moving at right angles to that direction. Señor Ventosa, of the Madrid Observatory, told him that the declination of the needle at that point was about 15° W. The photographers, he believed, were quite successful in their efforts. Dr. Rambaut had since told him his photographs had come out satisfactorily, and he understood that those taken by Prof. Joly and Mr. Wilson had also come out satisfactorily, so that their efforts, as a whole, were crowned with success. Mrs. Downing was engaged looking for stars, by the help of a chart giving the positions of the principal stars at the time, with reference to the sun, and during totality she was able, by the aid of her opera-glass, to see ϵ Tauri, magnitude $3\frac{1}{2}$, about 2° S. of the sun, and υ Tauri, magnitude $4\frac{1}{2}$, about the same distance N. of the sun.

Mr. Maunder said the party at Algiers was a fairly large one, and those of them who were in Norway on the occasion of the 1896 eclipse would have a reminder of that expedition, because in the photograph of the Bay of Algiers which they had on the screen before them they saw their old friend the "Norse King," which took them to Norway. They had the good fortune at Algiers to be accommodated together in one hotel, so that they were able to help each other and confer frequently with regard to their plans. They were, of course, by no means so large a party as when going out on the "Norse King," in 1896, and they had not the time for full drill and partition of duties which they had arranged on the occasion of that expedition; but still they filled up their time, he thought, pretty thoroughly before the eclipse. His own party consisted of his wife, his two daughters, and himself, and they made their observations from the roof of the Hôtel de la Régence. The instrument his wife used was lent by the kindness of Mr. Coleman, F.R.A.S., a Member of the Association, and was a 4-in. telescope equatorially mounted, but without a driving clock. On this telescope they mounted two cameras, each with a rapid rectilinear lens of focal length 18-in., which they used with a stop of 1½-in. aperture. His wife exposed her plates for 48 secs.—practically all they could expose in a duration of only one minute—in both cameras. He personally used the same mounting as in India—one lent him by the Royal Astronomical Society. It was a mounting which belonged to Mr. Sidney Waters at the time of the expedition to Norway in 1896; but soon afterwards Mr. Waters died, and he had bequeathed the instrument to the Royal Astronomical Society, the Council of which lent it to him (the speaker) for both the Indian and the recent eclipse. They mounted a pair of Dallmeyer stigmatic lenses on it, and exposed them for 48 secs., one of the two lenses being the one they had used in India. On the roof of the same hotel Mr. and Mrs. Crommelin were observing; Mr. and Mrs. Brook were observing shadow bands, and the former made meteorological observations; Miss Martin-Leake was examining the corona with a 3-in. telescope, and drawing a small portion of it. Mr. Davies photographed the corona with the camera belonging to the Waters equatorial. Mr. Hodge had a stationary camera which he mounted on one of the chimneys of the hotel, and Mr. Thorp, who used the camera, also viewed the eclipse with his opera-glasses. Several photographs of these and other observers, taken by Miss Edith Maunder, were then thrown on the sheet, followed by a set of six photographs of the corona, taken by Miss Irene Maunder, Mr. Maunder remarking that coronas were very unsatisfactory things to show on the screen, for there was always a difficulty when making a lantern slide to know how far to bring up the density of the slide to show it best on the screen. A remarkable feature of the photographs—a feature which he had not clearly seen on any photograph of a previous eclipse—was the presence of dark rays in the corona; not mere rifts between two arms of the corona, but dark lines which seemed to stretch out on to the background of the sky itself. The planet Mercury, being very near the sun and very bright, had come out in almost every photograph of the eclipse. Although some of the

photographs were exposed longer than the longest exposures made in India, they were not able to trace the rays quite so far as in the case of the Indian eclipse, and he thought that this must have been either because they were not present, or else because the state of the sky would not permit it, since the longest exposures showed no more than quite short ones did. Mr. Maunder then showed a number of slides illustrating Mr. Evershed's encampment at the mouth of the Mazafram river, some 20 miles from Algiers, and added that most of the Members of the Association who viewed the eclipse from Algiers were present that evening, and would probably give an account of their observations. He desired to say, before passing from the eclipse, how it struck him personally. It was the third he had seen, and it impressed him as being the most beautiful of the three. He was also very much struck with the colour of the corona on this occasion. The corona he saw in 1886 and that in 1898 seemed to him to be white, but white rather of the kind and character of the whiteness of the electric arc—that is to say, steely whiteness. The corona on the occasion now under notice seemed to be of a warmer tint, more like that of cream or ivory. The difference, to his mind, was very striking indeed; indeed, it was the first thing that impressed him directly he saw the corona.

Mr. Crommelin, in supplementing Mr. Maunder's remarks as to what was done by the Algiers party, said they arrived about a week before the eclipse, and were able to devote a good deal of time to sight-seeing. Their longest expedition was to Mr. Evershed, whose encampment was some 25 miles away, and they were very much interested both in his preparations and in what they saw in the course of their journey. A visit was also paid to the Algiers Observatory, which was beautifully situated on a hill behind the town at a height of some 1,100 feet—a pretty stiff climb under a broiling sun. Mr. Crommelin had thrown upon the screen a view of the hotel from which his observations were made, and also photographs of the instruments he used. A tele-photo. lens was kindly lent by Mr. Cavan, but the photograph taken with this did not come up to his expectation, he thought, owing to spherical aberration in the lens. He also brought a Dollond 3-inch telescope, with which he observed the partial eclipse by projection, and during the first 50 seconds of totality studied the inner corona visually. Between them they observed all the four contacts. The first was observed by projection on a sheet of paper, and he did not think they were more than a few seconds late. Mr. Brook helped him in observing the first little notch. They had the exact point marked on the paper, and saw the moon encroach just as a very tiny notch, so that they could only have been very little late. The light was sensibly less a quarter of an hour before totality; the sun was at that time eclipsed about the same as at the greatest phase in London. From that time onward the light diminished very rapidly. They had three signals, which were given by himself. The first was given five minutes before totality, and the second at one minute, a bell being rung. After that, he watched the diminishing crescent projected on the screen. He arranged to give the third signal 10 seconds before totality,

and the signal he gave came out at 9½ seconds before the observed time of the beginning of totality, so that it was not much out. He observed Baily's beads beautifully on the projection They began to appear 20 seconds before totality, and when he gave the 10 seconds signal the whole crescent was broken up into beads. The edges of the beads looked quite straight, perpendicular to the moon's limb, not like the serrated edges of mountains, or anything of that sort, but absolutely straight cuts. As soon as he had given the 10 seconds signal he slightly changed the focus, and placed himself at the eyepiece to observe the corona. Mr. Evershed had kindly communicated by telegraph the positions of the prominences, and he had arranged beforehand to study the coronal detail round the largest prominence (position angle about 218°). He saw three coronal rays grouped fairly symmetrically about this prominence, which was a beautiful double one. During the last 9 seconds he examined the corona through a pair of opera-glasses, and immediately afterwards made a rough sketch from memory of the appearance it presented. Mercury was very brilliant. The polar plumes were distinctly visible, a large wing going down towards Mercury, and there being a similar one opposite.

Mr. C. L. Brook gave an account of the shadow-band observations which he, in company with his sister, Mrs. Arthur Brook, had carried out at Algiers, as a member of Mr. Maunder's party. He stated that the word "bands" was quite inapplicable to what they saw; the shadows were more like "ripples" on water, and still more like the lights and shades which appear to course over the tops of long grass when a moderate breeze is blowing; these all move in one direction, but each small element of the shadow ripples cannot be followed for more than a moment: it seems to elude the eye or dissolve away and another takes its place.

Answering some questions which had been drawn up in the "Journal" by Mr. E. W. Johnson, *Mr. Brook* said the "bands" appeared 3¼ mins. before totality. The number of bands visible in 10 secs. could not be counted for the reason he had given above. As to the direction of the motion, the whole set of "ripples" were travelling from about 30° W. of N. to 30° E. of S. Were they inclined to the direction of the motion? No, he thought not; at any rate, they could not detect it. He really forgot to take the direction and force of the wind at the critical moment, but at 5 mins. past 4, 7 mins. before the "ripples" first appeared, the wind was N. or a little E. of N., being very light. After totality (at half-past four) the wind was N.N.W., still very light, but rather stronger than before. The speed of the "ripples" was rather difficult to judge, but it was not great. He estimated it at 1½ yards per second. The width of the "bands" he could not tell, but there was more light than shade. They were always very faint, and after totality they gradually grew fainter, but somewhat irregularly. Their duration after totality was 5½ minutes, and they were then coming rather more from the westward than before totality. They did not look for them during totality. His sister, however, upon looking at the sheet when the signal was given that 60 seconds of totality were past, found it, instead of being white, of a dull grey hue, the surface being covered

with dark blotches of shadow which appeared to be in a state of violent agitation, coursing one another rapidly over the grey ground. (*An illustration was here thrown upon the sheet.*) These shadows could not be said to be in definite wavy lines, nor did any of the pictures of shadow bands convey the appearance she saw; they seemed to be irregular ovals in shape, about 6 inches by 8 or 9 inches, and to be arranged in rows in the direction from N.E. to S.W., the patches apparently rushing rapidly off the sheet in this direction, while the whole set of rows moved slowly from N.W. to S.E. This phenomenon was quite different from the light grey shadow ripples described before; it lasted 7 or 8 seconds and vanished instantaneously.

Mr. Evershed stated that his expedition to the Mazafram was devoted entirely to spectroscopic work; with the exception of the observation of prominences made before the eclipse, he undertook no observing of any kind on the day of the eclipse. He had previously explained to the Association that one reason for his choosing a station which was near to the edge of the line of total eclipse was that he expected to get about 30 or 40 seconds duration of the so-called "flash spectrum," instead of only having one or two seconds at second or third contact. He took very great pains to locate himself as near as he could, according to the large-scale maps of the district, and he selected a station which he ascertained to be 1·75 miles inside the limit of totality, as laid down by the "Nautical Almanac" office. Unfortunately, the latter appears to have been seriously inexact, for when the eclipse came on he was just outside the shadow, which passed away to the north of his camp. He could not vouch for the fact himself, for he was too much occupied, devoting his attention to the chronometer while making his exposures. His brother, too, was condemned to sit right in the middle of the hut, in the dark, and he, of course, saw absolutely nothing of the eclipse. Notwithstanding the fact that he was outside the zone of total eclipse, he found, on examining the series of photographs obtained, that four of them gave excellent images of the flash spectrum; and these showed that at his station there were still about 30 seconds available during which photographs of this spectrum could be obtained. The photograph exposed 15 seconds before mid-eclipse gave the spectrum at the sun's S. pole, and that exposed for 10 seconds at mid-totality gave a considerable extension of the bright lines towards the ultra-violet, reaching as far as λ 3500. All the photographs showed bands of continuous spectrum, proving that the eclipse had not been total; and, owing to the very mountainous nature of the S. limb of the moon, these bands were, in some of the images, broken up into narrow strips, between which the flash spectrum lines stood out strongly.

The *Rev. C. D. P. Davies*, a member of Mr. Maunder's party, said, that besides seeing Baily's beads, another phenomenon which he witnessed was that at the moment of totality coming on the moon distinctly seemed to jump forward. What struck him most was the appearance of the corona. It was the most magnificent sight he had ever witnessed, being very different from anything

he had ever seen in photographs. He hardly knew how to describe it. The nearest approach seemed to be a mass or forest of streamers, beautifully defined, with not the slightest approach to a halo or haze around them. The light was of a steely blue. Another noteworthy feature was that the moon appeared to be globular and not merely a flat disk. There was a distinct light upon the moon, stretching inward for a certain distance. Mr. Maunder, to whom he had spoken regarding this, thought that it might be due to earthshine, which during an eclipse of the sun would be very strong on the moon, but he (Mr. Davies) could not bring himself to ascribe it to that cause, and he was still rather inclined to cling to the opinion that the light he saw was the light cast upon the dark portion of the moon by the corona, which extended a very great distance from the limb of the sun, and might, as we would say, throw some light "round the corner." But what chiefly struck him was the glorious appearance of the corona itself.

Mr. E. W. Johnson showed some photographs of the "gathering gloom" taken at Elche, a few miles S. of Alicante, as totality was approaching, and after the end of totality. He also exhibited a photograph of the corona taken by Lady McClure, and two photographs of the eclipse taken by Mr. E. C. Willis. Other photographs were illustrative of a visit to Sir Norman Lockyer's camp at Santa Pola, of Dr. Copeland's telescope at Santa Pola, and of the scenery in the neighbourhood of Elche.

Mr. H. Keatley Moore read extracts from a report which he, jointly with Mr. Francis Gare and Capt. Alfred Carpenter, R.N., had prepared with regard to their observations, which were made at Manzanares, La Mancha, Spain. Mr. Moore and Capt. Carpenter drew the corona as seen by the naked eye. As there were but two draughtsmen, each had to take half the corona—a very large amount of work for one minute. A combined drawing was made immediately after totality, before the observers left their chairs, and of this a finished drawing (reproduced and exhibited) was made the next morning. Mr. Gare's work consisted in an attempt to measure photographically, by means of graduated screens, the intensity of the light of the corona, and also of that of the partially eclipsed sun before and after totality, similar experiments being made by Mr. E. W. Johnson at Elche. Good results were obtained from the plates exposed (for 30 seconds) to the corona, which were now ready for comparison and experiment. Shadow bands were not seen until within two minutes of totality. They then travelled at six or eight miles an hour; 20 were counted in two seconds. The colour of the corona was an intensely brilliant silvery white, definitely towards the bluish side, and away from the yellowish side of pure white. If he were not afraid of indicating too pronounced a colour, he would say it had an exceedingly faint amethystine tinge. The returning sunlight looked magnificently orange-yellow at its first appearance, by contrast, proving the tendency towards amethyst of the coronal light. He personally judged this corona to be of precisely the same colour as that seen in India in 1898, and the yellowness of the returning sunlight was equally marked there.

Mr. Hodge showed some photographs of the eclipse, and *Mr. Hy. Ellis*, who followed, said he had the advantage of being with Mr. Maunder's party. He went, however, without any idea of taking any serious observations. This being his first eclipse, he wished to see it, and see it he did most splendidly. The photographs of the corona shown on the screen, he said, did but scant justice to the naked-eye view. The colour was of a pearly-white, with very slight pink tinge. Mr. Ellis showed some snap-shot views of members of the party on the roof of the Hôtel de la Régence, including Mr. and Mrs. Maunder, with their instruments; also of Mr. Evershed's encampment at Mazafram, showing the general arrangement and his instruments. These were followed by views in Algiers—some streets in the old part of the town, the fountains of the Mosque, the Moorish buildings occupied by the French Admiralty as a torpedo station near the lighthouse, and then a view in the Jardin d'Essai and an Arab procession with flags and tom-toms which he happened to meet.

Mr. C. T. Whitmell (whose observations were made at Navalmoral, a Spanish village some 125 miles W.S.W. of Madrid) said that, though specially looked for, the sweep of the shadow was not observed either in the air or on the ground. Its velocity at Navalmoral would be about 42 miles a minute. No shadow bands were seen either before or after totality. At totality there was plenty of light to sketch by, and a watch was easily read. The brightness certainly exceeded that of the full moon, but the light was quite unlike moonlight, and resembled a late twilight. Mercury, Venus, Aldebaran, Betelgeux, Rigel, and Sirius were seen. The corona was sketched both as a whole and in quadrants. The sketches showed long fanlike streamers, extending from the sun's equator in both directions. A few bright red prominences were noted in the lower right-hand quadrant, and it was from this quadrant that the coronal streamers were longest, extending nearly to Mercury, then 2° distant from the sun's centre.

The Meeting adjourned about 7.20 p.m.

Reports of the Branches.

VICTORIA BRANCH (MELBOURNE).

The Second General Meeting of Session 1899–1900, was held at 31, Queen Street, Melbourne, on Thursday the 5th April 1900, at 8 p.m. The Rev. J. Meiklejohn, M.A., President, in the chair.

The Chairman referred to the sudden death of Dr. Sprigg, who was elected as one of the Vice-Presidents of the Branch at the last Meeting. The deceased gentleman was most regular in his attendance upon the Meetings, and took a most active interest in the Society.

Mr. E. F. J. Love, M.A., F.C.P.S., was elected as Vice-President to fill the vacancy.

Mr. George Smale read a most interesting paper on the New Planet Eros, which he illustrated by a diagram showing the orbits of the Earth, Mars, and the new planet. Mr. Smale was highly complimented for the manner in which he dealt with the subject.

A vote of thanks to the lecturer was proposed by Mr. Sugars, seconded by Mr. Miller, and carried unanimously.

The third General Ordinary Meeting of Session 1899–1900 was held at 31, Queen Street, Melbourne, on Thursday, 3rd May 1900, at 8 p.m. Mr. A. C. Macdonald, F.R.G.S., in the chair.

Mr. E. F. J. Love, M.A., F.C.P.S., contributed a most interesting paper on "Rowlands' Photographs of the Normal Solar Spectrum." These photographs, he said, cover the visible spectrum, and also the ultra-violet actinic radiations. The total length of the spectrum is 16 feet, so that Fraunhofer's dark lines can be examined and measured, and the lengths of the light waves producing them compared, with an accuracy of 1 part in 1,000,000. This was rendered possible by Rowlands' invention of the concave diffraction gratings, *i.e.*, a concave mirror ruled with fine lines by a dividing engine, the lines being the $\frac{1}{10000}$th of an inch apart. This piece of apparatus takes the place of the array of prisms and telescopes which constitute the ordinary spectroscope, and though so much simpler an arrangement is far more effective. The main difficulty of the method is the construction of the grating. It generally takes many months' searching before a diamond point suitable for ruling the fine lines can be obtained. Naturally, such a crystal, when found, is worth hundreds of times its own weight in other diamonds—at any rate, to the experimenter. Mr. Love exhibited enlarged copies of the photographs, which together, give a picture of the solar spectrum 30 feet in length. A scale photographed along with the spectrum allows the wave-length of any line to be read off accurately to the nearest $\frac{1}{250000000}$th of an inch.

The Secretary, on behalf of Mr. Smale and others, presented the Society with a very handsome pictorial chart, having twenty diagrams of different astronomical phenomena represented by it.

The thanks of the Meeting were tendered to Mr. Smale for his gift, and a vote of thanks was accorded to Mr. Love for his excellent paper.

Papers communicated to the Association.

The Light Streaks in Ptolemaus.

By A. STANLEY WILLIAMS, F.R.A.S.

In his paper "On the Duplication of the Canals of Mars," published in Part VI. of the "Journal," British Astronomical Association, p. 255, Mr. Goodacre has referred to some observations of mine relative to the light streaks in the interior of the great walled-plain Ptolemaus, from which it appears that very

few of these streaks are shown in the drawings of this formation sent in to him as Director of the Section for the observation of the moon, Mr. Goodacre, indeed, stating that so far as his "own "observations and those of other people go, there are only two "light streaks on the floor of Ptolemaus." No doubt most of the drawings and observations which he has received relate to the period when this part of the moon was obliquely illuminated by the sun, whereas the light streaks in question, like most other lunar light streaks, are best seen about the time of full moon; but nevertheless the facts stated by Mr. Goodacre have caused me some astonishment, since a considerable number of the streaks are so bright and easy that they ought to be readily observed even shortly after sunrise or before sunset.

As might be inferred from the foregoing remark, quite a number of light streaks are shown in Ptolemaus by good photographs of the moon. The Rutherfurd photographs, though no longer the best, are probably better known than any others, and I have represented in the accompanying diagram the chief streaks appearing upon two of these photographs; one dated February 27, 1871 (moon's diameter 11 inches), and the other May 14, 1870 (diameter 9½ inches). The photographs in question are only enlargements on paper, and most of the really delicate detail of the original negatives is consequently lost.*

The diagram was constructed in the following manner. A little sketch of the markings was first made from one photograph, and then another one from the other. The two sketches were then compared, and the diagram constructed from a combination of the two photographs, a few objects visible only upon one of them and perhaps due to photographic defects, being omitted.

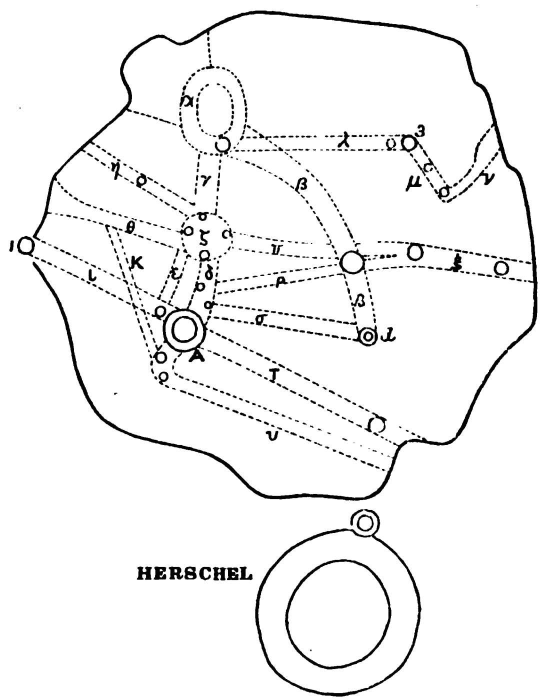
It will be seen that, if the circular bright patch ζ, which occupies the position of one of the curious saucer-shaped hollows, be counted as a streak, there are 19 distinct light streaks represented in the diagram. It is now many years since I last observed Ptolemaus, and the present diagram was purposely constructed without reference to any previous observations, in order that it might be as independent as possible. I have since compared it with my early observations, and find that every streak of the diagram except one is shown in these, and in substantially the same form. The excepted streak is the one marked μ, which rather curiously appears to have escaped my notice, though it seems quite distinct on both photographs.

It would be interesting if the Members of the Lunar Section would look up Ptolemaus when under a high illumination, and see how many of the streaks represented in the diagram can be seen. Probably there is nothing shown beyond the power of a good 3-in. refractor. With large apertures some of the simple streaks should appear more complex. The craters, hills, ridges, rills, and other features best observed near sunrise or sunset have hitherto almost monopolized the attention of observers, but it has

* The second edition of Proctor's "The Moon," contains a copy of the first of these photographs on a reduced scale (moon's diameter less than 4½ inches), and most if not all the streaks of the diagram are shown by this, notwithstanding the small scale.

always seemed to me that the light streaks, light spots, and other full-moon markings are of little less importance, and that it will probably be from the study of these that real change on the moon will ultimately be definitely *proved*.

The diagram, it should be mentioned, is not intended to be complete, and in particular a number of small light spots and some fainter streaks have been omitted. The apparent boundary of Ptolemaus varies considerably in places according to the illumination, but the large crater A, the bright little crater *d*, and the light spots 1 and 3 will serve as convenient landmarks by which to identify the various streaks. The boundary in the diagram corresponds approximately with the true boundary shortly before sunset, and was copied from one of Prof. Weinek's fine Lick enlargements.



LIGHT STREAKS IN PTOLEMAUS.

I presume that one of the two streaks mentioned by Mr. Goodacre corresponds with the bright oval α, the bright patch ζ, and the two streaks γ and δ; and the other streak with the one marked β in the diagram. Several other streaks appear about equally bright and plain in the photographs. The bright oval α is, however, brighter than any other streak.

Diffraction Gratings and Diffraction Spectroscopes.

By Albert Alfred Buss.

Read to Members of the North-Western Branch.
April 4, 1900.

The designation "grating" means a partition made up of parallel bars or lattice work, and this definition certainly was justified when the first gratings were brought into use. Fraunhofer, who was born 1814, experimented with gratings, which were obtained by stretching very fine metal wires at equal distances on a suitable holder. To-day, we know well how the evenness of a grating, that is the absolute parallelism and equidistance of the grooves or lines, affects directly the quality of the performance of a grating, and it seems wonderful how Fraunhofer, with the crude appliances he had to resort to, obtained such results as he did. Gross variation in distance of the wires was overcome by the application of very fine screws, over the threads of which the wires were stretched, but absolute parallelism and straightness were not so easy to obtain. Later Fraunhofer engraved close parallel lines or serrations into a plane glass surface covered with gold foil, and succeeded in making them as close as $\frac{1}{1000}$th part of an inch. He tried to make the lines still closer, but no gold was left on the glass, and the grating therefore became useless; still, with these comparatively coarse gratings, Fraunhofer was able to see all the principal lines which to this day bear his name. He found it also entirely immaterial whether the lines or grooves were opaque or transparent.

A grating of glass fibres, for instance, or even one made from fine hair stretched over a frame, produced all the desired phenomena. In fact he covered sometimes one side of a piece of plane glass with a layer of grease, so thin that it would scarcely be recognised by the eye, and on this surface he drew 2,000 parallel lines within an inch. Next, he ruled the lines or serrations with a diamond point into the surface of the plane glass itself, when he found what we hear repeated by the modern grating makers, that success chiefly depended on finding a suitable diamond point wherewith to rule the lines. We shall the more appreciate this when we remember that it took Prof. Rowlands often as much as eight months to find a good suitable diamond point. Fraunhofer succeeded at length, by persistent efforts, in making a ruling machine which ruled the lines so closely that they were indistinguishable with the strongest compound microscope, and he also found that the lines must be ruled so accurately that the variation in distance shall not exceed $\frac{1}{100}$ of the distance of one line from the next. Thus Fraunhofer established the fundamental necessities for successfully making gratings, and it is most interesting to peruse his memoirs and to see how very near he was sometimes to discovering what was done by successors. His method of ruling gratings on plane glass has been brought to a high degree of perfection by Nobert in Germany, and the latter has with special skill managed to engrave or rule as many as 100,000 lines within an inch. Clearly these gratings must be expensive to obtain, and

the number of fortunate possessors is necessarily few. Cheaper means were desired for their reproduction, and photography was resorted to by Lord Rayleigh with considerable success. In performance, however, all these were eclipsed by the products of Mr. L. Rutherfurd, of New York, and still more by Prof. Rowlands at the Johns Hopkins University, Baltimore, U.S.A. Certainly these latter gratings are by no means cheap, but they are far superior to anything previously obtainable, and as the Baltimore University have not allowed vulgar trade speculation to intrude, the gratings are supplied to scientific men privately, and at what must be called cost prices.

The gratings referred to before the last two mentioned makes come under the class of transmission or retardation gratings, in which the spectra are observed from the side opposite to the source of light, or nearly so. Rutherfurd's and Rowlands' gratings are, however, reflecting gratings, the spectra being observed from the same side as the source of light. The optical phenomena involved in both kinds of gratings are somewhat different, but yet sufficiently alike to render the understanding of both possible, by explaining the action of one kind. I shall confine myself in this respect to reflecting gratings, the theories of the transmission gratings being fully explained in almost any good book on optics.

Rutherfurd ruled the lines on the silvered surface of plane glass, the layer of silver being sufficiently thick that the resultant grating formed a reflecting one. Rowlands' gratings are ruled on the level or curved polished surface of speculum metal, and the ruling process has been previously described by me. These gratings being expensive, endeavours have been made with more or less success to reproduce them, and one of our own Members (Mr. Thorp) has obtained very promising results in getting replicas of reflecting gratings, mounting these on plane glass and using them in spectroscopes as transmission gratings.

Such is a condensed and, perhaps, incomplete history of gratings. There is, comparatively, little literature available on this particular branch of spectroscopy, more especially to an amateur.

Both kinds of gratings—transmitting and reflecting—may be united under the name diffraction gratings, and play as such a very important part in astronomical spectroscopy, especially the reflecting gratings in flat and concave form. It must be mentioned, however, that grating spectroscopes are generally only suitable where the source of light is a plentiful one, because of the great dispersion they cause. Still, even gratings in their most recent form, that is concave gratings, have been used with complete success for fainter sources of light, and Profs. Keeler and Campbell, of Lick Observatory, have obtained the first satisfactory photographs of stellar and even nebular diffraction spectra by their means. It has been the aim of optical inventors to concentrate all light into one particular order of the spectra, and one of the latest efforts in this direction is at present developing under Mr. Thorp's advice.

I will now refer briefly to one or two fundamental differences between prism and grating spectroscopes. The former yields but

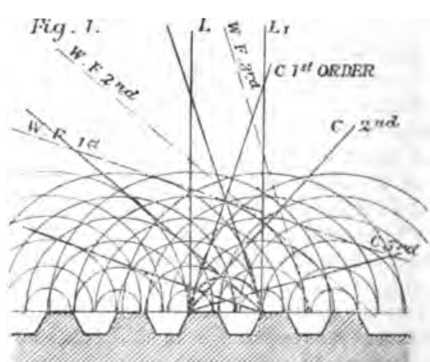
one spectral band, whereas the latter shows a series of them arranged symmetrically on either side of the central image of the slit. As regards the alternate appearance of colour bands and darker interspaces, the spectra produced by the transmission and the reflecting gratings are alike; still other optical phenomena are involved which cannot enter within the scope of this paper.

Diffraction must not be confounded with refraction, and it unites under its name quite a number of optical appearances. One of these is, for instance, that when light enters a dark room through a small opening, the image formed on the wall or screen opposite is found to be slightly larger than the actual size of the opening would justify, and is surrounded by a coloured fringe. Again, if a dark object, say a pencil, is interposed between the aperture and its image, the shadow of the pencil is larger or thicker than the thickness of the pencil would justify, and shows on both sides fringes of colour. Furthermore, the images of two small apertures close together when made to overlap, it is found that, contrary to expectation, the area of the overlap is darker than the remainder of the images. One would expect it to be, if anything, brighter, as it receives light from both apertures. This shows, that under certain circumstances light added to light results in darkness, and the phenomena of diffraction gratings are mainly due to the circumstances of the ether waves, of which light consists, interfere with each other and produce alternately brilliant effects of colour and spaces of darkness. This same effect produces in diffraction gratings the various orders of spectra visible on either side of the central image of the slit.

As we pass into the higher order of spectra, numbering from those next to the central slit image, we find the colour bands extending in length and diminishing in brilliancy. They extend so much in fact that they overlap, the end of an order being super-imposed on the beginning of the next. The colour bands all show the violet end towards the slit image and the red on their outsides, so that the red end of the second order is invaded by the violet beginning of the third order and so forth. When we hear of spectra of the 5,000th and 8,000th order, this overlapping and the consequent mixing up of the spectral lines must be correspondingly increased, and colour sifting or filtering prisms have to be resorted to, which complicate the instrument. These high orders of spectra are, however, only obtained in such special instruments as the Michelson échélon-gratings, which cannot be here described in detail, and which are only made for special work and the study of special rays.

For general work, and such as I have in view in this paper, the usual gratings with 14,438 lines per inch have been found by experience to be the most useful. More than 15,000 lines have not been found recommendable, and the number of 14,438 has been, for some reason unknown to me, accepted as a standard by the authorities at the Johns Hopkins University. This does not mean that closer ruled gratings are not better, but ordinary gratings of 14,438 lines per inch are quite sufficient for the observation to solar prominence and faculæ, spot spectra, and may also be used in a table spectroscope with satisfactory results. They give us a rule spectra up to the fourth or fifth order, and when mounted

in its holder fitted with collimator and observing telescope, and combined suitably with the body of the main telescope, we call the complete apparatus the telespectroscope. In mounting these spectroscopes on the body of the main telescope, it must be observed that the optical axis of the collimator coincides with that of the object glass, but when viewing the edge of the solar disk, it may be desirable to have the collimator axis set sideways to the extent of the semi-diameter of the focal image. It must not be thought, because an amateur has only a small aperture instrument, that a spectroscope is of no advantage. My own telescope is only just over (81 mm.) a 3-in. aperture, and yet the spectroscope gives me unlimited pleasure and satisfaction. To view a prominence of anything like a respectable size in its entirety in a large telescope where the focal image is correspondingly large, the slit has to be opened to such an extent that the outside or general illumination of the atmosphere counteracts the dispersion of the grating very materially, and renders observation indistinct, whereas a small telescope will allow of the slit being opened to the full height or width of a prominence. Thus while the large telescope enables the observer to scrutinise a prominence only in sections, but with more access to detail, the small telescope gives a better general view, but excludes detail, which is no disadvantage for an amateur. To return to the gratings, it may be stated that within certain limits, the closer the lines the better the dispersion and and the brighter the spectra. But there must remain a certain proportion of ruled to unruled surface to produce the diffraction. I find it stated that in the gratings more especially here under consideration with 14,438 lines per inch, about three-fifths of the surface is covered by the rulings, while the remaining two-fifths is in polished condition. At any rate, this is the case with Mr. Thorp's large grating. A section of a diffraction grating is shown in Fig. 1.



(54218) SECTION OF DIFFRACTION GRATING

Generally speaking, also, the more numerous the lines the higher the resolving power, or power to separate close absorption lines in the spectrum. The larger the ruled surface, the brighter also the spectra, as long as the collimator and the view telescope

are correspondingly large in aperture, and thus permit the utilisation of the entire ruled area.

In hardly any grating will it be found that the equal orders on either side are equal in brightness. Fraunhofer soon found this out, and remarked that the inclination of the diamond point with reference to the plane of the glass surface seriously influences the lines, and, further, that on ruling the lines, the diamond point may have such a position with reference to the surface to be ruled that one edge of each groove may be sharp, the other not so well defined, and although this may not be discernible under a microscope, still, the very inequality of the spectra referred to betrays this defect, which, however, is no serious impediment to the good working of the spectroscope.

That there must be a certain relation between the ruled and unruled portion of the surface to give the best result will be evident, when we take an extreme case, where the rulings are so wide or so close together that no reflecting surface is left. Such a grating would show no regular diffraction effects, but simply scatter the light in all directions like a ground surface. Again, if the scratches were made as wide as the intervening polished spaces, such a surface would reflect only half as much light as the same surface entirely unruled or free of lines. It follows, therefore, that the ratio of the total amount of light reflected from a ruled surface to that which is reflected from an unruled surface of the same area is as the sum of the width of the grooves to the sum of the width of the intervening spaces.

The brightness of diffraction spectra decreases with the square of their order, and the dispersion increases with the order, therefore, the brightness at any particular spot diminishes as the cube of the order. These are general rules on the main characteristics of diffraction spectra, deducted from their mathematical treatment.

There is another important difference between the prismatic and the diffraction spectrum to be observed. Comparing the spectrum rendered by a prism, or series of prisms, with that of a grating of equal dispersion, we find in the prismatic spectrum the red portion much compressed, and as we pass on to the violet through the yellow, green, and blue, see that these colours successively extend in length. The spectra of the diffraction grating are more uniform. This difference is due to the fact, that a prism does not yield a correct spectrum, because the dispersion it gives is not uniform, but is increasing as we pass from the red to the violet rays. The tables for wave-lengths give—

For red light - - $\lambda_r = 0{\cdot}0007601$ m/m

For violet light - $\lambda_r = 0{\cdot}0003963$ m/m

For yellow light the wave length is—

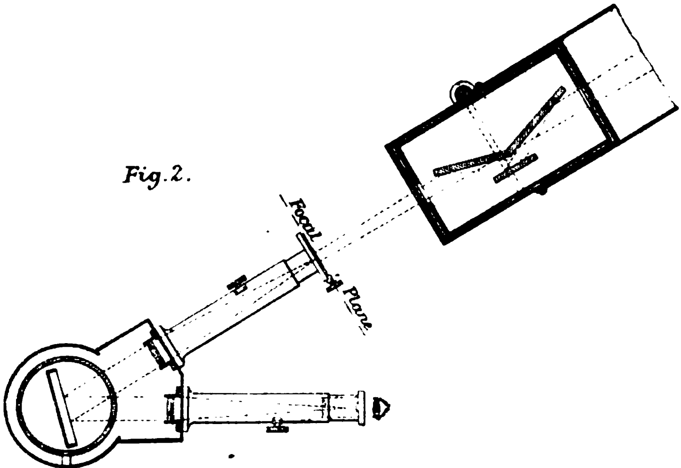
$$\lambda_y = 0{\cdot}0005782 \text{ m/m}$$

and this is numerically in the middle between the red and violet. We look, therefore, midway for the yellow in the spectral band, but find in the prism spectrum the greenish blue instead. We are thus forced to the conclusion that the prism spectrum does not afford the means for calculating the correct wave-lengths, whereas diffraction spectra do this, and are found, in fact, to be optically speaking—pure.

Regarding a complete diffraction spectroscope in simple form, and as it is likely to be found in the hands of an amateur, it will be evident from what we have said, that a good grating spectroscope has more dispersive power than a train of expensive prisms, with all their complication in mounting and adjustments. It is, therefore, also cheaper and simpler, and, I believe, also lighter in weight, which is a consideration with an appliance hanging at the end of a telescope tube, and naturally also requiring a balance weight.

In general the arrangement of a grating and a prism spectroscope are much the same. The focal image of the source of light is the plane of the front of the slit plate, or in other words the slit must be placed in the focus of the O.G. The light passes thence through the collimator, and is, by means of its lens, conveyed straight to the grating or to the prisms, where it is diffracted in the grating, dispersed or refracted in the prisms, brought out before the lens of the view telescope and observed through the eye-piece, which may have a power of from 5 to 20. In the diffraction grating under discussion few mechanical parts are required. It is desirable to have two kinds of slits for solar observation, an ordinary straight slit and a curved one, the curve being made exactly to follow the contour of the sun's image rendered by the O.G. on the slit plate. When using this curved slit, the lines in the spectrum are also curved, and when searching for prominences this slit has the great advantage of exposing the rim of the sun for a considerable length at one time, in my case fully one-fourth of the circumference. It is hardly possible for a prominence to escape, and while one might be under close observation another might rise up within the field of view, but which would not be detected if the straight slit were used. A prominence when once detected and selected for closer examination may be brought into most suitable position for the straight slit if desired by means of the rotator. In my particular case, with using a reflecting grating, it was most desirable to have a rotating arrangement, as shown in Fig. 2, so as to dispense with

Fig. 2.



moving the spectroscope itself round to get at different portions of the sun's image, involving often a very awkward position of the view telescope and also for the observer, and as you know, bodily comfort means a great deal in observing. This rotation is, in my case, accomplished by a simple combination of plane glass mirrors inserted into a cylindrical holder, closed at either end against dust. This rotator is inserted into the telescope tube where the eye-piece rack tube would be, the manipulation taking hardly one minute to accomplish. A milled head with a screw gearing into a toothed rack round the cylinder, allows of rotating the device to any comfortable observing position, and any portion of the chromosphere is brought into view at pleasure. Experiments and experience convince me that very little, if any, light is lost by the interposition of this rotator, which is also graduated, and thus allows of locating the prominences in solar latitudes.

In addition to observing prominences at the edge of the sun, the spectroscope affords opportunities for observing the spectra of sun-spots or prominences within the solar disk. These latter indicate their presence by a partial reversal of the line which has been selected for observation, generally *Cα*. If the prominence is very brilliant it may be viewed entirely by the opened slit. In a similar way, but with less ease, faculæ may also be observed, but to the writer faculæ seem identical with cloud prominences projected on the sun's disk. If the partial reversal is very brilliant indeed, the chances are that one has to do with an eruptive prominence, and the fact, that these mostly appear in the neighbourhood of spots, indicates to the observer where to direct his instrument. Another interesting matter for spectroscopic observation is distortion of the lines, indicating rapid movements in the line of sight, sometimes away from, and at other times towards the observer, sometimes in both directions simultaneously.

The early morning of a clear spring or summer day is the best time for observing the sun spectroscopically, when the atmosphere is quiet, comparatively free from smoke or dust, and not overheated. For special purposes, such as, for example, the study of the beautiful atmospheric lines, early morning or late evening are the best times, as then the sun's rays have to penetrate a deeper atmosphere. It may be more difficult to observe in partially cloudy weather, but the worst conditions for observing are when the sky is entirely overcast, or when a thin whiteish haze is present, for no detail can be made out then, although there may be plenty of light and the sun's disk may be quite easily visible. In partially cloudy weather I have often made specially good, if short, observations of prominences when these main conditions prevail :—

(1) A pronounced well-defined outline of the clouds;
(2) A fair number of bright intervals with absolutely pure blue sky between the separate clouds;
(3) That prominences are present.

The effect produced by the clouds alternately covering and uncovering the solar disk is surprising. With the slit set at right angles to the direction of the cloud drift (readily done by the help of the rotator), each time the sharp edge of a cloud covers or

uncovers the disk, the effects of an eclipse are present to a remarkable degree, and the chromospheric appearances and prominences show for a few moments brilliantly clear and well defined. It seems to me, that if we had a suitable satellite only at a distance from the earth of little more than such clouds, we should be able to view most, if not all, of the phenomena accompanying an eclipse.

Referring further to the instrument itself; in addition to the slits having their adjusting screws, the straight slit is provided with a comparison prism which is convenient when using the spectroscope for chemical experiments. The milled head of the curved slit is also graduated and allows direct approximate reading off in thousands of miles the height of prominences. Another milled head, provided with a pinion, rotates the circular table on which the grating is mounted, so as to be able to observe any order of spectra desired. The reflecting position of the grating may be used to look for spots in a general way. Seeing spots near the edge of the sun, and turning the image round to a suitable position as regards the slit, it is almost certain that prominences, however small, are seen in the neighbourhood. I observed on one occasion last year the distinct reversal of the Helium D_3 line seen across a group of spots, and have witnessed many interesting eruptions and distortions of lines.

Still another milled head with pinion gears into a rack underneath the casing of the spectroscope, giving thus the coarse adjustment to bring the instrument towards or away from the telescope and the slit into the focus of the object glass.

Both collimator and telescope have their usual necessary fine rack adjustments in addition to the foregoing.

Rods and clamps connect the spectroscope with the body of the telescope, as shown Figs. 3 and 4, and the whole constitutes

Fig. 3.

Fig. 4.

in appearance and in management a very simple, efficient, and self-contained arrangement. The casing is blackened inside to

prevent false lights appearing, and though the whole is only mounted on an alt-azimuth stand, I have no difficulty in getting the instrument to work. It is, of course, no easy matter to show to one who cannot manage the instrument himself, any prominences by standing on one side and trying to get the image of the sun suitably on the slit, but an equatorial mounting and clock motion would dispose of this difficulty. I have thus described in more detail my own spectroscope, because I think for an amateur it represents the type he may reasonably possess. There are, of course, a multitude of larger and more elaborate spectroscopes for professional work, but the simple arrangement described embodies all the essential points.

My reason for bringing this subject forward in the form of a paper is my conviction (judging from observation and intercourse with fellow Members) that an impression exists that the subject of spectroscopy is a very deep one, requiring special study before venturing on the matter at all. I have no wish to treat the subject lightly, but having ventured on its threshold, I found it accessible to the average intellect so as to encourage me to proceed in this most interesting study. I may mention at this point, regarding instrumental means, that with the new transmission gratings, the rotator may be dispensed with, since the instrument forms practically a direct-vision one, and the conditions referred to about the necessity of a rotator when using a reflecting grating are not quite the same for a transmission one. A simple rotating device is certainly necessary, but it forms part of the spectroscope itself, and is less expensive than the rotator described. Both kinds of instruments may be used also as table spectroscopes.

In conclusion, I may be allowed to offer a few remarks as to keeping such instruments in good condition :—

(1.) The edges of the slit must be kept as clean as possible, and if dust is there, use a wooden match point to remove it, rubbing only gently, so as not to blunt the slit edges which must be sharp for good definition.

(2.) Keep all the lenses clean, and especially those of the eye-piece of the view telescope.

(3.) Treat the grating with the utmost care, and, if a reflecting grating is used in a mount, have a glass cover for it to prevent any coarse dust from getting to the ruled surface. The cover will also protect it from accidental knocks or touch by hand.

(4.) Clean the grating only when necessary. Use for the removal of dust a soft camel-hair brush, and stroke gently in the direction of the lines, not transverse. If the ruled surface of a reflecting grating has got tainted or dull, washing with ammonia and a lump of fine cotton sliver, which has been treated on the combing machine, may be resorted to. But this must only be done when really necessary. This washing must again be done by gently stroking the surface in the direction of the lines, and the surface must be dried with another piece of cotton sliver, and when quite dry any fibres adhering removed with the camel-hair brush. I am not acquainted with a corresponding means of

cleansing transmission gratings, but the information can doubtless be had from the grating maker.

(5.) Keep all in a dry place and out of danger from being knocked about.

(6.) All adjustments must be made carefully and deliberately in proper order of succession before proceeding to observe.

I trust that the information thus conveyed may induce many of my fellow Members to take up astronomical spectroscopy. It is a wide and interesting study, and I doubt not but that Mr. Evershed, the able Director of the Spectroscopic Section of the Association, will gladly welcome additional workers in this special branch of astronomical work.

Observation of the "Green Ray."

By Col. E. E. MARKWICK, F.R.A.S.

I have often seen the phenomenon of the "green ray" at sunset, on the disappearance of the very last bit of direct sunlight, but never so satisfactorily as on the 6th June 1900, from the deck of the P. and O. S.S. "Caledonia." We were getting out of "the Bay" on the homeward voyage from Gibraltar; the sea calm, and the sun brilliant down to the horizon with little or no tinge of red. Just before the last ray had disappeared behind the dark horizon of the ocean, its light changed most distinctly from white or reddish white to a green or bluish green. It was evidently changing in tint, but the time it lasted was so short, not more than two or three seconds at the outside, that we could not satisfactorily note the change through the spectrum from red towards violet. It was seen by three other Members of this Association who were returning from observing the total eclipse of the sun in Spain.

On the previous evening I had watched the sun set on the ocean. On this occasion it was a dull red, and there was not the slightest sign of any change to green when finally disappearing. It is evident that one requires the horizon to be quite free from haze to see the phenomenon properly.

Partial Solar Eclipse, 1900, May 28.

(As seen at Norwich.)

By G. J. NEWBEGIN, F.R.A.S.

The ten negatives accompanying this paper (of which lantern slides will be shown) were taken during the partial solar eclipse of 1900, May 28.

The sequence was unfortunately rendered incomplete by accident to one plate and non-exposure in the other case; they consist of odd numbers throughout, and where the unfortunate hiatus occurs I have introduced two lantern slides from the even numbers to make the sequence on screen look more complete.

They were taken with the $4\frac{1}{4}$-inch photo-visual of Cooke's make, an exposure of $\frac{1}{400}$ sec. being given in each case.

There appears to be a very uniform curve to the moon's limb, what little inequalities there may be being due more to atmospheric disturbance than anything else.

Clouds were much in evidence at the time of first contact, which was invisible; the last contact was recorded at $4^h\ 55^m\ 5^s$ and I am inclined to believe at that time the moon's limb was actually clear of the sun by one or two seconds, the eye seeming to watch it gradually withdraw into space.

The estimated point of first contact is $111°\cdot5$ from N. point; the recorded point of last contact is $248°$ from N. point; from this I have endeavoured to calculate the amount of maximum obscuration as seen at my locality and it works out at $0\cdot531$ of sun's area.

	Times of Exposure.		
	h	m	s
No. 1	2	59	33
" 3	3	5	50
" 5	3	18	56
" 7	Broken		
" 8	3	34	51
" 9	Not exposed		
" 10	3	45	36
" 11	3	54	1
" 13	4	5	28
" 15	4	13	42
" 17	4	24	35
" 19	4	33	43
" 21	4	45	26
" 23	4	50	51

Correspondence.

Occultation of Saturn by the Moon (June 13th, 1900).

The occultation was seen by a perfectly clear sky and good images; the instrument was a $4\frac{1}{2}$-inch O.G. refractor, magnifying 160.

Ingress.—The planet was very pale, much less bright than the lunar disk, and even than the floor of Grimaldi or Plato. I saw no abnormal appearance on the rings on the ball of Saturn. No dark band on the lunar limb.

Egress.—Same appearance; the egress was regular. Saturn was always very little bright, but no trace of a lunar atmosphere. After 10 or 18 minutes, the planet was seen to the naked eye.

M. Moye,
Professor to the University.

Montpellier (France),
June 15, 1900.

Partial Solar Eclipse, 1900, May 28.

I beg to inform you that the partial solar eclipse of yesterday was observed by me at Playford, a village about 4 miles N.E. of Ipswich, through a 3-in. telescope.

The weather was fairly good, but with many light broken clouds driven by a slight W.N.W. wind.

The commencement took place at 2.42 G.T.

The finish at 4.56 G.T.

Both these observations were made when the sun was clear of clouds.

In the middle of the eclipse I could not detect the disk of the moon beyond the sun.

I think the light was generally admitted, during the greatest observations, by all the company near me, to have been something not quite usual, but of a peculiar, reduced, shaded glare, of a yellowish tint.

There was no Venus visible, probably too many thin clouds about.

I may mention, however, that I saw her quite distinctly here this evening at 7 o'clock with naked-eye in bright sunlight.

Upland Gate, Bishop's Hill, G. A. BIDDELL.
Ipswich,
29th May 1900.

Partial Solar Eclipse, 1900, May 28.

Probably many Members of the British Astronomical Association took photographs of the late eclipse, when only a small arc of the sun's limb was hidden, without observing the actual contact, and the following table, which gives approximately the time from nearest contact when certain arcs, up to 36 degrees, of the sun's limb were eclipsed, may be useful. Of course the smaller the eclipsed arc is, the more accurate will be the times given.

Arc of solar limb eclipsed in degrees.	Time for nearest contact in seconds.
4	2
8	8
12	18
16	33
20	51
24	73
28	99
32	130
36	164

This table was calculated by taking the versed sine of half the sun's eclipsed limb, adding it to that of half the moon's eclipsing edge (the sun's radius being taken as unity), and multiplying this sum by the time the moon's centre required to move with respect to the sun over an angle equal to the sun's semidiameter, and again by the secant of the angle included between a line joining the points of contact and a radius of the sun to either point. This table illustrates the great apparent rapidity with which an eclipse begins and ends.

108, Grange Road, S.E., DAVID SMART.
14th June 1900.

Partial Solar Eclipse, 1900, May 28.

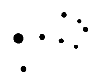
Observation taken at Wavenden Manor, Woburn Sands, R.S.O.

12 18.—Wind light, W.N.W., barometer 30·8.
Cloudy.—Electrical disturbance. Cumulus cloud towards S.
Light nimbus towards E.

Through a Five-Inch Refractor.

Sunspot observed May 27, 3.15 p.m. G.M.T.

Sunspot observed May 28, 12.42 G.M.T.



May 28.—1 p.m.—Cloudy.
2.25.—Lighter cloud.
2.30.—Sun shining.
2.47.—Clouded.
2.49.— „
2.50.—Disk became visible. Eclipse had begun.
3.22.—Wind light, shifting towards N.
3.47.—Observed a thickening of both cusps with rift of light between.
3.55.—Phase of greatest shadow.
4.15.—Shadow passing.
4.57.—Shadow passed.

Sky clear since 4 p.m. in the afternoon.

We searched in vain to see if stars were visible, either to a binocular or to the unaided eye. There was no great apparent diminution of light supply, and although the sky overhead was clear during the later phases of eclipse, we could not succeed in making out "Venus," nor was "Mercury" visible.

Hillside Cottage, Wm. C. Tetley.
Aspley Guise, R.S.O., Beds.,
May 29, 1900.

The Ages of Sunspots: Erratum.

An error occurs in the list of mean observed ages of Sunspot groups (p. 320) which I regret escaped detection on revision. The age for 1899 ought to be 7·69 instead of 8·82 days. The mistake is due to my having inadvertently taken, in the case of two disturbed areas, the times during which the areas were disturbed instead of the ages of the outbursts constituting the disturbance. In each case the first feeble outburst died and was followed in a few weeks by another outburst in the same position. The percentages of groups of different ages for 1899 thus become respectively 57·7, 30·8, 5·8, 0·0, 1·9, and 3·8. The rise in 1899 of the dotted curve in the diagram is a little less than shown, but otherwise its character is unaffected.

1900, June 16. Wm. Anderson.

The Denver Observations of Eros.

Your correction (p. 334) of the statement in "Nature" of June 7 that Prof. Howe, of Denver, photographed the planet Eros during the total eclipse of May 28 is itself not quite correct. For you say that "it was four hours before the eclipse that the photograph was taken." Prof. Howe's observations were not photographic, but visual, the first of the kind, Prof. Pickering believes, since the last conjunction of Eros with the sun, for the Arequipa observations in the latter part of April were photographic. Prof. Howe secured (A.N., No. 3647) two visual observations with the following results:—

G.M.T.	R.A.	N.P.D.
d	h m s	° ′ ″
May 27·90729 - -	23 47 3·43	87 13 32·7
„ 27·91859 - -	23 47 4·37	87 13 21·4

W. T. LYNN.

Notices of the Association.

Messrs. W. Gordon Miller and Henry Ellis have been appointed Auditors to examine the Treasurer's balance sheet and the Accounts of the Association for the session ending 1900, September 30.

Total Solar Eclipse, May 28, 1900.

The Eclipse Committee have resolved to issue a report of this eclipse uniform in character with "The Indian Eclipse, 1898." This will be supplied to Members of the Association subscribing at 5*s*. a copy. Members desiring to subscribe are requested to fill up the enclosed form and return it to the Assistant Secretary.

New Members of the Association.

ELECTED 27TH JUNE 1900.

DR. JAMES LAMBIE, Lowick, Beal, Northumberland.

MRS. ADA MARY MASKELYNE, 88, Trinity Road, Upper Tooting, S.W.

MISS MARY ELIZABETH WOOLSTON, High Street, Wellingborough.

Candidates for Election as Members of the Association.

31st October 1900.

Conrad W. Cooke,
"Rothley," Macauley Road, Clapham Common, S.W.
Proposer—W. H. Maw. *Seconder*—E. Walter Maunder.

Franz Haffbrl,
20, Jubiläumstrasse, Mödling in Wien, Austria.
Proposer—Henry Ellis. *Seconder*—E. Walter Maunder.

Henry Human, Assoc. Inst. Elect. Engineers,
62, Birdhurst Road, Croydon.
Proposer—P. E. Vizard. *Seconder*—A. C. D. Crommelin.

Rev. Frederic William Quilter, D.D.,
The Vicarage, Kempey, Worcester.
Proposer—E. Walter Maunder. *Seconder*—A. C. D. Crommelin.

J. H. Reynolds, F.R.A.S.,
Malvern House, Trinity Road, Birchfield, nr. Birmingham.
Proposer—Harold Whichello. *Seconder*—William Schooling.

Percy William Stanger,
7, Falkland Road, N.W.
Proposer—H. Homer Metcalfe. *Seconder*—Fred. J. Vincent.

Wm. Ford Stanley, J.P., F.R.A.S.,
Cumberlow, South Norwood, S.E.
Proposer—Chas. T. Whitmell. *Seconder*—Washington Teasdale.

Miss Ellinor Thorold,
Warkleigh House, Umberleigh, R.S.O., North Devon.
Proposer—Harold Whichello. *Seconder*—William Schooling.

Miss Sarah Ann Urquhart,
c/o W. Urquhart, Esq., L.C.C.,
107, Portsdown Road, Maida Vale, W.
Proposer—J. Stark Brown. *Seconder*—Thos. Frid Maunder.

Additions to the Library.

Presents received.

Wislicenus—Astronomischer Jahresbericht. I. Band.

Todd—Total Eclipse of the Sun. New edition.

Nautical Almanac Circular, No. 18. Local Particulars of Total Eclipse of the Sun, 17 May 1901.

Wilson—Astronomical and Physical Researches made at Daramona.

Notes.

THE ROYAL ASTRONOMICAL SOCIETY.—The ordinary Meeting of the Society was held on Friday, 1900, May 11, in Burlington House, Mr. E. B. Knobel, *President*, in the chair. *Mr. Maw* said that 52 presents had been received since the last Meeting, and the *President* drew attention to the fact that a sub-section had been formed in the British Association to deal with astronomical subjects. The *Rev. G. L. Cortie* read a paper on the Duration of the Greater Sun-Spot Disturbances in the years 1881–99 The *President* asked what was the range in latitude of a group which lasted for more than 20 rotations and extend over 30° or 40° of longitude, *Mr. Cortie* replying that the latitude extended from 13° to 27° S., and *Mr. Maunder, Mr. Newbegin, Mr. M. Horner*, and *Mr. Maw* joined in the discussion. The *President* then called on Dr. Gill to tell of the work and new buildings in contemplation of the Cape Observatory, and Dr. Gill spoke of the Cape "Durchmusterung," according great praise to Prof. Kapteyn for his share in the work, of the investigations on the parallaxes of southern stars, of the catalogue of 3,007 stars, and especially of the trigonometrical survey of Africa. *Mr. Newall* asked if Dr. Gill could tell the nature of the spectra of the separate components of Alpha Centauri, and *Dr. Rambaut* asked if it would be possible with the McClean spectroscope to distinguish between the comparison stars of the helium type and others. *Prof. H. H. Turner* criticised the high standard for which Dr. Gill strove, especially in the case of the Astrographic Chart, and after *Dr. Gill* had replied to all the speakers, the *President* called upon the Members of the various eclipse expeditions to speak, and *Prof. Turner, Mr. Newall, Mr. Maunder* spoke on this subject.

The last ordinary Meeting of the Session was held on Friday, 1900, June 8, Mr. E.B. Knobel, *President*, in the chair. *Mr. Dyson* called special attention to the present received from Mr. W. E. Wilson of the volume of Astronomical and Physical Researches made at Daramona. A paper was read from *Mr. Denning* on a meteoric shower south of Corvus, and *Prof. Alex. Herschel* commented on it. *Mr. Newbegin* read a paper on the solar eclipse of 1900, May 28, and the *President* called on Sir David Gill to give an account of the McClean telescope. *Sir David Gill* showed on the screen the plans of the building, mounting, moveable floor, and methods of moving the telescope, and accounts were then received from the Members of the various eclipse expeditions. The *Astronomer Royal* recorded his indebtedness and thanks to the Portuguese Government, to Mr. Frank Rawes, to Mr. Campos Rodrigues, and to Mr. Oom. *Prof. Turner* described the work undertaken by Mr. Newall and Mr. Wesley, and *Mr. Newall* concurred with Prof. Turner in his thanks to M. Trépied, director of the Algiers Observatory, and described his photographs of the flash, and his polariscopic photographs,

saying that he believed that he had for the first time photographed the Savart bands. *Mr. Dyson* expressed his debt to the Portuguese Government, and his personal obligation to Mr. Atkinson, and *Mr. Wesley* described what he saw of the structure of the corona through the equatorial coudé of the Algiers Observatory. *Mr. Maunder* described the programme which he and his wife had carried out in India, and which they extended on this occasion. He said that they had not succeeded in getting as long extensions as in India, but that their photographs confirmed the discovery made then that the synclinal curves terminated in rod-like rays. *Mr. Crommelin* gave an account of the time-determination, and of his drawing of a portion of the inner corona. *Dr. Johnstone Stoney* read a paper on the cause of the shadow bands seen during the progress of total eclipses, and *Mr. Franklin-Adams* showed some photographs of the corona taken at Santa Pola in Spain, *Dr. Spitta* also showing three photographs taken at Algiers by Mr. Hodge. A discussion then followed between *Mr. Maunder, Mr. Franklin-Adams, Prof. Turner*, the *Astronomer Royal, Mr. Newall*, and *Capt. Hill*, on the colour of the corona.

THE ROYAL OBSERVATORY, GREENWICH.—The official visitation of the Royal Observatory was held this year on June 26, it having been postponed from the first Saturday in June owing to the Astronomer Royal and several members of the staff being absent on various eclipse expeditions. The Astronomer Royal also held two "At Homes," on Monday, July 2, and Wednesday, July 4, when ladies were invited. The chief features of interest at all three were, of course, the coronal photographs taken on the 28th of May previously. The large scale photographs taken by the Astronomer Royal in India in 1898 were placed for comparison with similar ones taken in 1900, and the different points of structure were well seen. Another point of interest was the observations of Capella which had been discovered by Mr. Newall to be a spectroscopic double, and which was lately found in the 28-inch refractor at Greenwich to be visually double also.

MINOR PLANET NOTES.—Signor Millosevich has computed (A. N. 3650) new elements of (433) Eros with the aid of the recent observations. Applying perturbations he deduces the following values for the last and coming oppositions:—

Epoch and Osculation.	1898, Aug. 2·5.	1900, Oct. 31·5 Berlin M.T.
	° ′ ″	° ′ ″
M	205 21 14	304 25 3
π	121 11 3	121 9 59
ω	177 39 19	177 39 21
Ω	303 31 44	303 30 38
i	10 49 29	10 49 33
ϕ	12 52 6	12 52 32
μ	2015″·330	2015″·295

The following is an outline ephemeris (for Berlin midnight):—

Date.	R.A.	N. Dec.	Date.	R.A.	N. Dec.
1900.	h m s	° ′	1900.	h m s	° ′
July 21 -	1 20 41	19 17	Oct. 9 -	2 43 12	47 52
Aug. 10 -	1 51 55	25 53	„ 19 -	2 35 48	51 5
„ 30 -	2 19 25	32 56	„ 29 -	2 21 4	53 25
Sept. 19 -	2 39 12	40 24	Nov. 8 -	2 1 21	54 22

The planet is nearest to the earth on December 26, when its distance is 0·3148, and parallax 27″·96.

A.J. 483 contains a paper by H. N. Russell on the great inequality of Eros and the earth. He finds for the perturbations in mean longitude of Eros $+ 747'' \sin (7g - 4g^1) + 100'' \sin (14g - 8g^1)$, where g, g^1 are the mean anomalies of Eros and the earth. The period of the first term is 41·24 years, and the whole range of its effect on the planet's place, as seen from the earth, is nearly 3°. We may thus hope to eventually deduce the sun's parallax by this method with greater accuracy than by any other. Mr. Russell notes that he made some abbreviations in his computation, so the results are approximate only.

The planets (440), (445), have been named Theodora and Edna respectively.

THE TOTAL SOLAR ECLIPSE OF 1900, MAY 28.—"The Meeting of the Royal and Royal Astronomical Societies to hear the reports of the observers sent out under the auspices of the Joint Committee of the two Societies took place at the Royal Society's rooms on Thursday, June 28, at 4.30 p.m. The following summary of the proceeding gives in brief the main results of the eclipse. The chair was taken by Lord Lister, Mr. Knobel occupying the secretary's chair on his right.

"The Astronomer Royal showed three photographs of the corona taken with the Thompson 9-inch object-glass and telephoto concave lens, giving a scale of 4 inches to the sun's diameter; two of these, taken near the middle of totality with exposures of 6 and 12 seconds respectively, showed details of the inner corona and the equatorial streamers to a distance of about two diameters from the limb. The polar plumes were also well marked. The third plate, exposed near the end of totality for 2½ seconds, showed the chromosphere with a large prominence on the south-west limb. The Astronomer Royal also exhibited two photographs taken by Mr. Davidson, one with a 4-inch lens of 34 inches focus, the other with a special rapid lens of 13 inches focus, both taken with 3 seconds' exposure, and showing the extensions of the corona. Of these the picture taken with the longer focus appeared the better, and it was stated that with such a combination giving $\frac{f}{8}$ a longer exposure did not seem advisable.

"Sir Norman Lockyer related that he had 120 officers and men of H.M.S. "Theseus" at his disposal. He showed spectra of the

chromosphere at different distances from the limb; also plates showing the spectrum rings of the corona, the ring due to the green ray at 5308·7 and two others. It was pointed out that the rings are of totally different character from the chromospheric arcs, and have their greatest brightness at places other than where the chromospheric arcs are brightest. Photographs of the corona were also shown, taken by Mr. Howard Payn and by members of the ship's crew: one taken with a Taylor photo-visual lens of 4 inches aperture and 16-feet focus with 5 seconds' exposure, was considered good, the chromosphere being well marked all round the limb, and a large amount of detail of the inner corona well shown. A photograph taken with a Zeiss anastigmatic lens of 9 inches focal length with a Thorp grating mounted in front, the exposure being 40 seconds, shows a streamer—the N.E quadrant—to a distance of 4½ diameters. No long extensions of the equatorial streamers could be detected by carefully-made eye-observations. Sir Norman stated that the corona was like that of 1878, not only in general form, but also in the minute structure of the inner corona, which was distinctly different to that seen in 1871. Also there were no bright lines, such as were seen in 1871, in the spectrum of the corona either in 1878 or in the present year.

"Prof. Turner warmly acknowledged the kind reception and efficient help that he and the other observers at Algiers had received from M. Trépied. He explained by a diagram the principle of observation with a polariscope, and showed photographs of the corona in which the effect of polarization could be distinctly seen. He also showed photographs of the corona and stated that measures not less complete had been made of its light, from which it was inferred that the corona of this year was comparatively bright. Prof. Turner made some introductory remarks on the merits of the cœlostat as part of the equipment for eclipse observation.

"Dr. Copeland showed photographs of the corona taken with the telescope of 43-feet focus and with a telescope having an object-glass of Iceland spar. The greatest extension of the corona was one diameter from the limb.

"Mr. Evershed explained that he had gone, with his brother as assistant, to a station further west than Algiers, to a place which he thought, from the data of the British "Nautical Almanac," was just on the south edge of the shadow track, where it was expected that totality would last 30 seconds, and that the chromosphere would have been seen all that time. Unfortunately the eclipse was not seen as total at this station. Some natives who were 500 metres north of Mr. Evershed saw a total eclipse; others, 500 metres south, said that the sun did not wholly disappear. The edge of the shadow of the moon was distinctly seen crossing the land north of the eclipse station. Nevertheless, photographs of the spectrum of the chromosphere and prominences were secured, and these were shown on the screen.

"Mr. Newall showed spectra taken with a slit spectroscope at Algiers and with a Savart polarising prism.

"Mr. Dyson showed photographs of parts of the spectrum of the chromosphere taken with a slit spectroscope exactly at the beginning of totality.

"Mr. Knobel congratulated the observers, but expressed a wish that wet collodion plates had been used.

"Lord Lister also expressed his satisfaction at the results of the eclipse."

The Observatory, July.

RESUSCITATION OF AN OBSERVATORY.—On the death of Dr. J. J. Jedrzejewicz at the end of 1887, the observatory which he had founded at Plonsk, and where he had devoted his leisure time to the observation of comets and double stars, passed into what now appears to have been a state of suspended animation. After an interval, however, of about 10 years, means were raised for its restoration, but not in the same place. It was re-established at Warsaw (a short distance to the north-west of the University Observatory there) in the summer of 1898, and possesses a 6-in. refractor by Steinheil, a 5-in. refractor by Cooke, provided with clockwork, a meridian instrument with objective of 2½ inches aperture, and two small circles, together with several spectroscopes and other appliances. Herr Merecki has for some time past been diligently mastering the use of these instruments, and it is hoped that before long something will be heard of the results obtained. (**Ast. Nach.**, No. 3643.)

On the occasion of the opening of the new laboratories in connexion with Owens College, Manchester, the degree of Doctor of Science of the Victoria University was conferred, on Saturday, June 30th, by the Chancellor, Earl Spencer, upon two astronomers, Sir William Huggins, K.C.B., and Professor E. C. Pickering, of Harvard College, U.S.A.

Astronomical Publications.

THE TOTAL SOLAR ECLIPSE OF MAY 28, 1900. *E. Walter Maunder.*—In one important respect the eclipse of January 1898 differs from that successfully observed in May 1900. In the former, owing to the position of the line of totality, the observers were, comparatively speaking, massed together at the central portion of the line. Their conditions either of time or weather did not therefore greatly differ from each other. In the latter eclipse, however, observers were obliged to occupy the ends of the line, and therefore the great advantage was obtained of being able to compare results both coronal and spectroscopic before and after the interval of a few hours. Particulars of the work undertaken by various observing parties in Spain and Algiers are given, together with a reproduction of a beautiful drawing of the corona by Miss C. O. Stevens. (**Kn.**, July 1900.)

THE TOTAL SOLAR ECLIPSE IN AMERICA.—The Lick expedition, under Messrs. Campbell and Perrine, had a narrow escape from clouds at Thomaston, Georgia, the sun being obscured one minute after third contact. The photographs taken with the

40-foot camera are very fine, and the slow plates used with the Floyd telescope show the streamers to four times the solar diameter. One of the plate driving clocks of the spectroscope failed at the critical moment, but one exposure to the corona was obtained.

Miss O'Halloran, observing with an opera-glass at New Orleans, also saw the totally eclipsed sun in a clear interval. The light was equal to early twilight. The inner corona, which was visible to the naked eye nearly one minute before totality, was shallow and inconspicuous; the outer recalled that of January 1889. The western wing, extending about 1° from the moon's limb, and widening outwardly, its upper edge pointing almost directly to Mercury, had a sharp outline throughout. The eastern wing was not so distinct except at the base, and tapered to invisibility before extending fully a degree. The south polar rays were curved, pointed, and conspicuous. The general tint of the corona resembled that of fleecy white clouds half-an-hour after sunset. (**A.S.P.**, June.)

THE NEXT TOTAL ECLIPSE OF THE SUN.—"Nautical Almanac Circular," No. 18, contains local particulars of the eclipse of 1901, May 17. The most easily accessible positions in the eastern portion of the shadow track, with the corresponding durations of totality, are—

	m	s
Mauritius - - - -	3	35
Padang, Sumatra - - -	6	14
Pontianak, Borneo - - -	5	40
Fort Victoria, Amboyna - -	4	15
Port Moresby, New Guinea - -	3	19

A map of the region is included in the circular. (**Nat.**, June 28.)

MEASURES OF EROS.—"Harvard Circular," No. 51, contains the results of measures of photographs taken in 1893, 1894 and 1896, the complete discussion being reserved for a volume of the Observatory "Annals." These measures show that the Harvard photographs give the means of tracing the path of any moderately bright object since 1890 with nearly as great accuracy as if it had been observed with meridian instruments. (**Nat.**, July 5.)

THE PERSEID METEORIC SHOWER.—Mr. Denning writes that it is of little use to continue accumulating observations of the radiant point near the maximum, August 10, 11. What is really required is a series of observations during the latter half of July, the sky being watched all night if possible, and the results for each day kept separate, in order to trace the diurnal motion. The conditions are favourable this year as the moon reaches its last quarter on July 19. (**Nat.**, June 21.)

ANCIENT RECORDS OF METEOR SHOWERS.—M. D. Eginitis, Director of the Athens Observatory, in his report for 1899, gives a short account of some ancient records. A shower, lasting all night, is recorded by the patriarch Nicéphore; no date is given, but

historical statements fix the epoch in the autumn of 752. Three periods of Biela's comet correspond to 20 years, and as remarkable showers of Bielids occurred in 1852, 1872, 1892, that of 752 may have been an earlier apparition of the same group, or the different showers may have been produced by a continual slow disintegration of the comet. Théophane and Cédrinos record a large comet in 745. Cédrinos also describes a shower in the autumn of 558, and a large comet in 518, the interval being six times the period of Biela's comet. This offers evidence of a second series of showers of similar period but different epoch. The showers of 1798 and 1838 would fall into this group. April showers recorded in 763 by Théophane, and in 1122 by Domno Alberico would correspond with the Lyrids, but one of April 1094 recorded by Alberico cannot be connected with any known radiant. (**Nat.**, June 28.)

THE TRIFID NEBULA, M. 20, IN SAGITTARIUS. *J. E. Keeler.*—A beautiful photograph of this nebula has been taken at Mount Hamilton with the Crossley reflector, exposing the plate for three hours. It agrees well with the drawings of Lassell and Trouvelot, but shows much more than they do. The three main rifts described by Sir John Herschel ramify in all directions, like the roots of a tree, and there are many others through the fainter part of the nebula, which do not appear in the drawings. The triple star near the centre is seen on the negative, but is lost in a bright patch of nebulosity on the enlarged photograph.

Dr. Holden thinks that the earlier drawings compared with the later and with photographs, afford evidence of change in the relative positions of the nebula and involved stars. But no such change is apparent since 1835, and Herschel's drawing of 1833 was only a rude sketch, partly from memory. The oftener one has to compare drawings and photographs the less importance one attaches to evidence based on the former. (**A.S.P.**, June.)

DOUBLE STAR ASTRONOMY. *W. J. Hussey.*—For about 40 years, dating from 1782, Sir W. Herschel, their discoverer, was almost the only observer of binary stars. His work was afterwards continued by his son in conjunction with South, and by William and Otto Struve. During the 30 years following the publication of the catalogue of double stars found with the famous Pulkowa refractor, very few more were discovered, but many observations made of those already known, by Struve, Mädler, Dawes, Secchi, Dembowski, and others. The revival of the search for new doubles dates from 1870, since when 1,290 have been found by Burnham, and about 2,200 by Hough, See, Innes, the observers at the Cincinnati, Washburn, Harvard, Arequipa, and Lick Observatories, &c. Many of these are very close, and a large number are in rapid motion. The study of double stars is now attracting many observers, but the literature is so scattered that it is often less trouble to make a new set of observations than to find out whether such observations are needed or no. Two volumes, therefore, of recent publication, which classify some of the material available, are specially welcome. The Yerkes Observatory has brought out "A General Catalogue of

"1,290 Double Stars discovered from 1871 to 1899, by S. W. "Burnham," and the Royal Observatory at the Cape of Good Hope, a "Reference Catalogue of Southern Double Stars, by R. T. A. Innes."

In both these catalogues only doubles within a low limit of distance apart have been admitted. There are wide pairs which obviously have some physical connexion. These may best be studied by measurement of large scale photographs, but for close pairs the camera cannot compete with visual observations. (A.S.P., June.)

ASTRONOMY WITHOUT A TELESCOPE. VI. THE MILKY WAY. *E. Walter Maunder.*—The Milky Way is pre-eminently a naked eye object, and if we are to gain any adequate knowledge of its structure we must supplement telescopic and photographic examination by the most careful and thorough scrutiny with the unassisted sight. The careful mapping of this object is astronomical work of a high order of importance. Suggestions for the accomplishment of this are given, the difficulties met with being similar to those experienced in drawing the zodiacal light. (Kn., July 1900.)

THE ESCAPE OF GASES FROM PLANETARY ATMOSPHERES. *G. Johnstone Stoney.*—In this paper Dr. Stoney gives reasons why Maxwell's Kinetic Theory, developed by S. R. Cook in a previous article, leads to results which are probably very wide of the truth at the limits of an atmosphere.

Maxwell's law of distribution of molecular speeds in an isotropic gas is a probability law, and is never more than approximately fulfilled even under the limiting conditions assumed in the proof of the law. It is widely departed from when the total number of encounters between molecules within a given space is too small, and it more nearly represents the actual state of things the larger the number of encounters, provided certain conditions are complied with.

These are all practically fulfilled in ordinary air. But the law does not hold with very thin layers, as when tobacco smoke is confined between slips of glass, in this case the flakes of smoke may be seen under the microscope to be in rapid movement due to abnormal molecular "rushes."

Other instances are adduced where the law ceases to be a safe guide, and it signally fails near the boundary of an atmosphere where an opportunity is afforded to molecules having an abnormal speed to place themselves beyond the reach of the encounters which should tone it down; and in all cases where there is an insufficiency of those encounters which eliminate anomalies the larger deviations would grow to be more numerous and of larger amount than the law would tolerate.

The results obtained by Mr. Cook are considered to be of use in that they furnish a rate of escape which the real rate must exceed. (Ap. J., May.)

THE KINETIC THEORY OF PLANETARY ATMOSPHERES. *G. H. Bryan, F.R.S.* (*Abstract of a paper read before the Royal Society, April* 5.) The object is to investigate the conclusions obtained by applying the Boltzmann-Maxwell distribution, taking

account of the planet's axial rotation. The surfaces of equal density cease to be closed surfaces when passing outside the line on the equatorial plane along which the centrifugal force balances the planet's attraction. The surface through this line is called the "critical surface," and the ratio of the density at the planet's surface to that at the "critical surface" is called the "critical density ratio." The high value obtained for this ratio in the case of helium and the earth shows that this gas could escape only very slowly at ordinary temperatures. Further calculations show the number of years in which the total amount of gas escaping across the "critical surface" would be equal to the amount of gas in a layer covering the surface of the planet to a depth of 1 cm. This is independent of the total amount of the gas in the atmosphere, since the rate of flow and the amount in the surface layer increase in the same proportion. For helium and the earth the results give $3 \cdot 5 \times 10^{36}$ years at -73° C., 3×10^{19} years at 27° C.; for hydrogen and the earth, $8 \cdot 4 \times 10^{10}$ years at -73° C., 222 years at 27° C.; for water vapour on Mars, $1 \cdot 2 \times 10^{33}$ years at -73°, $1 \cdot 9 \times 10^{16}$ years at 27°. The leakage of helium from the earth and water vapour from Mars must, therefore, be very inconsiderable as compared with the total quantity of these gases in their atmospheres. (**Nat.**, June 21.)

A SECOND SPECTRUM OF HYDROGEN BEYOND λ 185 $\mu\mu$.—*V. Schumann.*—A new spectrum of hydrogen was discovered in 1893 in the extreme ultra-violet beyond 185 $\mu\mu$. It is now found that a second spectrum exists in the same region. The two spectra, although apparently very similar, are demonstrated to be not in complete agreement either in distribution of energy or in refrangibility. Neither of them exhibit any tendency to the broadening of the lines at high pressures which characterises the well-known spectrum in the less refrangible region. (**Ap. J.**, May.)

CORRECTION OF THE CALENDAR.—M. Joseph Laïs points out that the year would be kept at its true length over very long periods of time by retaining the Gregorian rule with the addition of not dropping a leap year at the end of each period of 3,200 years, and suggests that this would be a better plan now than the one advocated by Lord Grimthorpe, Mr. Lynn, and others, of abolishing the Gregorian rule and substituting one dropping a leap-year at the end of each successive period of 128 years. The simplicity of the latter rule is in its favour, but it is always desirable to avoid fundamental changes if possible, and it is too often forgotten that in this matter we have to consider where we start from. By the Gregorian arrangement A.D. 2000 will be a leap-year, also A.D. 2400, 2800 and 3200; but M. Laïs's proposition is to make the last of these an exception. Now the length of a tropical year is 365·24220 days; the average length of a Gregorian year (which contains in 3,200 years 2,424 common and 776 bissextile years) is 365·24250 days. These differ then by 0·00030 of a day, which, in 3,200 years amounts to 0·96000 of a day, or within so small a fraction of a whole day that if a shift were made at each of these periods by arranging that its closing year should *not* be a leap-year, the reckoning would be kept correct for many thousands of years. (**C.R.**, July 2, Tome CXXXI., No. 1.)

Variable Stars.

Star.	Maximum.		Minimum.		References.
	Date.	Mag.	Date.	Mag.	
W Aquarii	1899, July 12	10·27	—	—	A.J., 9.
Y Aquarii	„ July 13	9·1	—	—	„ 9.
U Aquilæ	„ Sept. 18·8	—	1899, Aug. 26·4	—	„ 23.
X Aquilæ	—	—	„ Oct. 24	—	„ 9.
Z Aquilæ	1899, Sept. 13	8·72	—	—	„ 9.
RR Aquilæ	„ Sept. 7	—	—	—	„ 9.
RS Aquilæ	—	—	1899, June	—	„ 9.
— *Aquilæ* (Anderson's).	1899, June 29	6·7	—	—	„ 9.
— *Aquilæ* (D.M. +15°4082).	„ July 1	8·32	—	—	„ 9.
„	„ July 10	8·27	—	—	„ 9.
„	„ Aug. 3	8·57	—	—	„ 9.
„	„ Sept. 20	8·35	—	—	„ 9.
R Capricorni	„ July 11	9·0	—	—	„ 9.
U Capricorni	„ Oct. 22	—	—	—	„ 9.
X Capricorni	„ Nov. 14	—	—	—	„ 9.
Z Capricorni	„ Oct. 24	—	—	—	„ 9.
X Cygni	„ Sept. 28·1	—	1899, Nov. 9·0	—	„ 23.
RZ Cygni	„ Aug. 19	—	„ Dec. 24	—	„ 9.
„	„ Aug. 16	—	„ Nov. 1	—	„ 9.
R Delphini	—	—	„ Aug. 8	—	„ 9.
V Delphini	1899, Sept. 29	—	—	—	„ 9.
X Delphini	„ July 1	8·47	—	—	„ 9.
T Monocerotis	„ Oct. 4·58	..	1897, Jan. 23·32	—	„ 23.
Y Ophiuchi	„ Aug. 6·2	—	—	—	„ 23.
U Orionis	„ Apr. 13	6·1	—	—	E.M., 377.
U Pegasi	„ Sept. 27·35	8·95	1899, Sept. 28·4	—	A.J., 24.
„	„ Oct. 1·33	8·96	„ Sept. 30·37	—	„ 24.
V Pegasi	„ Aug. 5	8·6	—	—	„ 9.
— *Pegasi* (Anderson's).	„ Sept. 20	8·75	—	—	„ 9.
S Sagittæ	„ Aug. 9·4	—	1899, Sept. 15·4	—	„ 23.
„	„ Sept. 21·3	—	„ Nov. 6·7	—	„ 23.
T Sagittæ	„ Aug. 25	—	—	—	„ 9.
„	„ July 21	—	—	—	„ 9.
R Sagittarii	„ Aug. 29	7·4	—	—	„ 9.
S Sagittarii	„ July 2	9·8	—	—	„ 9.

Star.	Maximum.		Minimum.		Reference.
	Date.	Mag.	Date.	Mag.	
U Sagittarii	1899, Aug. 14·51	—	1899, Aug. 25·97	—	A.J., 23.
„	„ Sept. 3·79	—	„ Sept. 6·89	—	„ 23.
W Sagittarii	„ July 28·79	—	„ Aug. 8·38	—	„ 23.
„	„ Sept. 3·51	—	„ Sept. 7·30	—	„ 23.
Y Sagittarii	„ Aug. 30·34	—	„ July 1·74	—	„ 23.
„	„ Sept. 5·93	—	„ July 30·54	—	„ 23.
Z Sagittarii	„ Oct. 1	9·94	—	—	„ 9.
T Vulpeculæ	„ Sept. 11·54	—	1899, Sept. 10·39	—	„ 23.
„	„ Sept. 20·58	—	„ Sept. 23·33	—	„ 23.

THE PRESENT APPEARANCE OF JUPITER. *A. Stanley Williams.*—Notwithstanding the low altitude of Jupiter at the present time, some interesting changes have been recently observed. The great red spot is now much plainer and redder than it has been for some time past, being so obvious as to attract attention before the hollow. The N. equatorial belt is now considerably redder than the S. equatorial belt, the contrary being the case last year; while the bright equatorial zone has changed from tawny to a pale white. In view of the low altitude of the planet it is desirable that southern observers should note the changes of colour in the belts. (**Obs.**, July.)

NOTES ON SATURN AND HIS MARKINGS. *W. F. Denning.*—It is certain that there are occasional irregularities on Saturn. In 1790 Sir W. Herschel saw a very dark spot on the limb, and in 1793 was able to determine the rotation period from irregularities on a quintuple belt, and it is probable that these belts exhibit irregularities like those of Jupiter. But it is also certain that many of the abnormal results more recently reported as obtained with small instruments, although made in good faith, are really the products of imagination. Occultations are rare, but there will be another on September 3, disappearance taking place at $7^h\ 16^m$, and reappearance at $8^h\ 11^m$ p.m.

At every opposition the number and appearance of the belts should be noted, a dark polar cap should be looked for, as well as any dark or light spots on the belts or intervening zones. Evidence obtained in past years is discordant, some observers seeing one or two belts, whilst others, with more powerful means, have recorded seven or eight; some seeing the belts and zones mottled with spots, whilst others record them as free from all such irregularities. New and trustworthy observations are greatly needed as to the actual character of the details visible. (**Nat.**, July 5.)

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The Journal

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VOL. X. SESSION 1899-1900. No. 10.

REPORT OF THE COUNCIL ON THE WORK OF THE TENTH SESSION, OCTOBER 1899 TO OCTOBER 1900.

I.—Progress of the Association.

The British Astronomical Association entered on its Tenth Session on Wednesday, October 25, 1899, when the Ninth Annual General Meeting was held at Sion College, Victoria Embankment.

The Membership of the Association has increased by 8 during the year, and on the 30th September 1900, amounted to 1,159, as compared with 1,151 the previous year.

The Council regret to report the loss by death of 19 Members as follows:—

Miss E. M. Bardwell, Rev. E. L. Berthon, A. Caplatzi, Rev. G. T. Carruthers, Joseph Casartelli, Fredk. R. Cooper, Gen. Alexis de Tillo, W. H. Devine, N. E. Green, John Jackson, W. E. Matthews, B. T. Moore, Mrs. L. A. Oakes, T. M. Purday, Dr. W. T. Radford, Saml. Robert, T. G. Rylands, Wm. Shawcross, Jas. Gordon Sprigg.

And four deceased since the new list of Members was published:—

Sydney Hodges, Prof. J. E. Keeler, John Romanes, Rev. T. A. Strong.

It will be seen that the death-roll is a very heavy one. The Association suffered especially through the death of Mr. N. E. Green, F.R.A.S., formerly President and Director of the Saturn Section.

No Conversazione was held this year in consequence of the preparations for the Total Solar Eclipse.

In spite of the failure of the proposed expedition by special steamer, a large number of Members visited America, Portugal, Spain, and Algeria, for the observation of this eclipse, and all were favoured by fine weather. The report of the expeditions to observe this eclipse will shortly be published as a separate volume, similar to that published after the 1898 eclipse.

In the editorial department, besides the regular issue of the "Journal," the following separate "Memoirs" have been issued

during the year. The reports of the Sections for the Observation of Meteors, the Sun, Jupiter, Coloured Stars, also that of the Photographic Section. The Editor desires to take this opportunity of expressing his hearty thanks to Messrs. Bacon, Bouton, Crommelin, Evershed, Gare, Johnston, Levander, Lynn, Saunder, Seward, and to Miss M. A. Orr, for their kindness in undertaking the abstracts, and assisting in other ways in the preparation of the "Journal."

The enclosed Table shows the state of Membership up to September 30, 1900.

—	Membership, Oct. 1, 1899.	Elected.	Reinstated.	Resigned.	Deceased.	Lapsed.	Membership, Sept. 30, 1900.
England	716	56	—	28	15	2	727
Wales	16	—	—	2	—	1	13
Scotland	123	13	—	10	—	1	125
Ireland	43	—	—	1	—	—	42
Europe	53	1	—	1	1	1	51
North America	39	—	..	2	1	1	35
South America	3	1	—	—	—	—	4
India	13	2	—	—	—	—	15
Australasia	123	11	2	6	1	2	127
Africa	20	—	—	—	—	1	19
China and Japan	2	—	—	—	1	—	1
	1,151	84	2	50	19	9	1,159

II.—The Observing Sections.

These have been actively engaged during the year. In addition to the separate "Memoirs" mentioned above, reports have appeared in the "Journal" from the Directors of the Saturn, Meteoric, Lunar, Double Star, Variable Star, Zodiacal Light Sections, and reports from the Solar and Meteoric Sections are included in the present number.

Solar Section.

The sun is now passing through a period of almost absolute calm, such spots as do appear being quite insignificant in size. The percentages of days with and without spots for the first half of the present year were from Prof. Moye's observations 54 and 46 respectively, the number of days of observation being 103 of a possible 183. In the preceding quarter, October to December 1899, the percentages from Mr. Hadden's observations were 44 and 56, the sun having been observed on 43 of possible 92 days. Comparatively few drawings have accordingly been received from Members of the Section. The Director would call attention to the interesting experiments of one of the Members, the Rev. A. East, on the mode of formation of the mottled surface of the sun, some

account of which appeared in the June number of "Knowledge"; and also to a suggested classification of sun-spots according to prevailing phases of the single type, to which they all seem to conform, proposed by the Director of the Section at the recent Meeting of the British Association at Bradford. The partial eclipse of the sun of May 28, 1900, was well observed by several Members of our Association; and a paper on the chief results obtained appears in the present number of the "Journal."

Solar Spectroscopic Section.

This has not been a record year as regards the number of drawings obtained of the solar prominences, and observations on sun-spot spectra have been practically nil.

Two observers only have contributed observations, and as the early months of the year appear to have been everywhere unfavourable for the work, there are some serious breaks in the continuity of the record. The expedition for the observation of the solar eclipse also put a stop to regular observations at the Director's observatory from April until August. A few drawings were, however, secured at his eclipse camp in Algeria.

Although there have been no sensational outbursts of solar energy witnessed this year, large prominences are still occasionally to be seen. On January 14, for instance, the western limb presented a magnificent spectacle, the complicated detailed structure of two very large prominences being especially well seen on this occasion. It is to be regretted that observations are not attempted more frequently during the winter months when the definition is often extremely good even at mid-day.

In all 64 complete drawings have been obtained during 1900 up to date (September 22); a few of these being duplicate observations by two or more Members contributing. The mean daily number of prominences derived from these is 6·76, showing a very slight decrease compared with the second half of 1899, which was 6·90. The two hemispheres show an exact equality as regards mean numbers, but the southern prominences were, on the average, larger than the northern in the ratio 19 to 18.

Only one metallic prominence has been recorded; it was seen on September 21 on the W. limb in 2° N. latitude.

Lunar Section.

The number of Members comprising this Section is now 40, which shows an increase of 10 during the past year; notwithstanding this increase, the number of communications received by the Director has been disappointingly small, so that material for another volume of Memoirs of the Section accumulates all too slowly.

It may be thought by some observers that the great advance in Lunar photography has rendered visual work with the telescope unnecessary; how erroneous this view is may be shown by the fact that the best photographs do not show more than one-tenth of the detail visible in a good telescope, so that for a long time to

come it must be through visual observations alone that our knowledge of the lunar surface can be advanced.

It is in the correct delineation of this fine detail that even the best modern maps of the moon break down.

The difficulties of the task are great, but not insuperable, and it is fully within the capacity of the Members of this Section to construct maps of the whole or considerable parts of the moon which shall be reliable and accurate in every way.

A suggestion that the Lunar Section of the British Astronomical Association might attempt something in this way has been recently made by Mr. S. A. Saunder, M.A., and he has very kindly done a great deal of preliminary work to put the plan upon a sure basis. Space will not permit of a detailed account of the proposed scheme; it may suffice, however, for the present to mention that a portion of the moon's surface about 13° or 14° square near the centre and in the S.W. quadrant has been selected, and this divided into four parts. A map of each is being drawn from photographs on a scale of 200 inches to the moon's diameter. These sections will measure 10 inches square, but the size of the map will be 11 inches square, allowing half an inch for overlap on each side. The task of making these skeleton maps (in which finer detail is to be correctly inserted by the aid of the telescope) is a very difficult one, and requires draughtmanship of no mean order. The Association is, therefore, under great obligation to Mr. B. E. Cammell, who is taking this portion of the work in hand. The Director hopes soon to be in a position to issue these skeleton maps to Members who would like to take part in this preliminary effort, which, if successful, will be extended to other parts of the moon.

Mars Section.

Owing to the fact that the planet was in conjunction with the sun in 1899–1900, the Section was necessarily in abeyance.

The Report for 1898–1899 is now ready, and will appear towards the close of the year. The Director much regrets that, owing to the pressure of his duties at Juvisy, and with the great telescope of 49 inches aperture and 187 feet focal length at Paris, he could not issue the Report, which is of a similar character to those of 1892 and 1896–1897, earlier than this.

Jupiter Section.

In consequence of the low southern declination of the planet, and the generally unfavourable weather for observing during the year, comparatively little has been done by the Members of the Section. The Director has, so far, received a return from one of the new Members, Mr. Garrard, of Louth, Lincolnshire, with seven drawings, and a short note from the Rev. T. E. R. Phillips, of Yeovil, with reference to transits of spots, at which branch of observation he has been diligently working, and a statement of his work will be received later on. Capt. Molesworth will, no doubt, send a full statement of his observations, and with the advantages

of the clear air of Ceylon and its southern latitude his work is certain to be of great interest. It is to be hoped that returns will be received from several Members in England, and some from observers resident in the southern hemisphere, but the Report is unlikely to be so full as usual.

Saturn Section.

The planet has been very unfavourably situated for observation, and consequently not many observations have been made. Mr. H. J. Townshend and Mr. F. G. Garrard have, however, made some careful observations which we hope to be able to publish in the usual course. Both observers agree in seeing only two belts upon the planet instead of three as on former occasions.

It may be that owing to the great distance and low altitude of the planet, some 14° only, that the third belt has been missed.

Mr. Townshend has made some observations on the colour of certain areas on the planet which are probably due to atmospheric refraction, and Mr. Whitmell has contributed a paper on the theory of such coloured areas. There has not been time to compare the observations with the theory, but both contributions will appear in full later on.

Comet Section.

Very few comets have been observable during the year, and only one has been conveniently placed for the possessors of telescopes of moderate size in this country. This was Comet b 1900 (Borrelly-Brooks); a considerable number of observations of it was obtained by Members of the Section, which will shortly appear in the "Journal."

Mr. Tebbutt and Mr. John Grigg obtained numerous observations of Tempel's Second Periodic Comet last year.

Attention should be called to the very valuable computations on cometary orbits which have been carried on by Mr. C. J. Merfield, of Sydney, N.S.W. His work goes admirably hand in hand with Mr. Tebbutt's observational work.

Dr. Smart has again given much kind help in computing ephemerides.

Meteoric Section.

The work of the Section has been pursued with increased activity, and a considerable number of observations have been obtained. Many of the more feeble minor showers have been successfully observed, and some brilliant fireballs have appeared. The real paths of the great majority of these were computed. Among the most notable fireballs of the year may be mentioned those of January 9, $2^h\ 55^m$, July 17, $8^h\ 47^m$, and September 2, $6^h\ 54^m$.

Messrs. Antoniadi, Astbury, Backhouse, Besley, Bridger, King, Johnson, Phillips, the Director, and several others, have contributed observations. Prof. A. S. Herschel has also sent in a mass

of results, and his accurate observations and real path determinations are of great value and interest.

Though the display of Leonids in 1899 proved a failure, the Members of the Section will watch eagerly for the shower at the middle of next November. The moon will be near the last quarter and rise at about midnight, but will not seriously interfere with the display should it re-appear in its richest character.

The Director has been compelled to resign owing to ill health, but the duties of the Section have been fulfilled by Mr. W. E. Besley, as Acting Director.

Variable Star Section.

The programme indicated at pp. 112–114, Vol. X. of the "Journal," has been adhered to. A further working list of 34 variable stars has been prepared and notified by circular to Members of the Section. These, with the 12 notified in the report in the "Journal" just alluded to, form a list of altogether 46 of the principal variable stars, on the observation of which the Section is now concentrated. To afford variety, and thus please respectively observers with the naked eye, opera glass, and telescope, the principal types of long period, short period, Algol-type, and irregular stars have been included.

Charts of the vicinity, where necessary, have been prepared for these stars, and lists of comparison stars with the Revised Harvard Photometry magnitudes compiled, and distributed. Thanks are due to Prof. Pickering for furnishing complete lists of comparison stars for certain long period variables. The object has been, in these charts, to enable any one with an ordinary knowledge of the sky to identify the vicinity of a long period variable, by no means an easy task for an amateur unprovided with circles, when the variable concerned is in its fainter stages. For this purpose a chart has been prepared giving (1) the naked eye or bird's eye view of the locality on the scale of Proctor's smaller atlas; (2) view as seen in the opera glass on the scale of the maps of the "Uranometria Argentina," or about $1^\circ = 0{\cdot}34$ inch; and (3) telescopic view on scale of $1^\circ = 3$ inches. These, together with certain circulars on general subjects, have been reproduced by hectograph, and sent out.

The labour in this has been considerable, and the want of a copy of the map or catalogue of the "D. M." is much felt. Hagen's star atlas would also be of great assistance when completed for the northern hemisphere.

A compact following of some 12 Members have responded warmly to the call for observations, as will be seen by the fact that quite 676 observations have been received up to date, the discussion of which will form plenty of work now that the maps are completed. The "short period" determinations of brightness will be arranged according to "phase."

As an illustration of what can be done by co-operation, 124 observations of R Leonis were made by Members up to 31st May last These were all plotted to scale, and the light curve drawn, showing the maximum to have occurred, with considerable probability, on April 7–8. It is thought that no single observer in

England, be he ever so active, could hope to secure so many observations in four months on account of clouds, &c. But when several observers are scattered over the country, one will have fine weather when it is cloudy elsewhere, so every one helps in turn to fill up gaps. Hence, it is apprehended, a good field of work lies before the Section.

One Member, Mr. G. W. Middleton, has resigned through ill-health, and the following three Members have joined since the list at p. 248, Vol. X., was prepared :—

Ivo F. H. Carr Gregg.
Laurence Child.
J. M. Peridier.

The number of working Members may at present be regarded as 12.

Coloured Star Section.

The past year has seen the completion of the results of the past six years in the form of what is believed will prove to be the most complete catalogue of truly red and orange stars which has yet been formed. This catalogue was published July 25 last, and may become the basis of further work in this field. The Director suggests as work still needing to be performed a more complete survey of the southern hemisphere as regards red stars, and the collection of green and blue stars from the Heavens generally. He desires to take this opportunity of resigning the Directorship of the Section.

Double Star Section.

Some of our Members have done a considerable amount of work in measuring double stars, but their results are generally in continuation of a series of contributions to other societies. The necessity of more instrumental means than is possessed by many militate against this line of research.

Photographic Section.

The Director regrets the lack of interest manifested by many of the Members connected with this Section. There seems to be in evidence a want of the enthusiasm so necessary a factor for success, especially in Celestial photography. It is hoped that next season may be more fruitful in results.

Mr. David Ross, of Melbourne, has sent photographs of his equipment and hand-driven pictures of the Southern Cross and pointers, &c., exposure 40 minutes. Mr. Henry Ellis suggests that much attention is required in the development of negatives so as to get a uniform result, and remarks that similarity of exposure in similar instruments does not necessarily mean similar pictures, even with like treatment in developing, and that there seem to be many degrees of transparency of the air which are difficult to detect. In reference to the same subject, Mr. Gavin J. Burns, B.Sc., also sends interesting details.

Another matter in which Mr. Gavin Burns has made several experiments is the relation between exposure and aperture. It appears that for stars, as in ordinary photography, the exposure must vary inversely as the square of the aperture (for the same lens).

Mr. Longbottom reports that owing to cloudy skies, and to much time having been taken up in experiments, he has no report of work done during the last season.

In reference to the transparency of the air, as a rule, the Director always found that the best effects were obtained when the fainter portions of the Milky Way shone clearly out, and that the finest days rarely portended a clear evening, but perfect evenings often broke out suddenly from a sky completely overcast.

Mercury and Venus Section.

This Section consists of eleven Members, and a number of them sent in reports and drawings during the past session. The Director has also received numerous notes and drawings from Members of the Association, but who are not enrolled Members of the Section; he much appreciates these contributions, and desires to impress upon the Association the necessity of a wide collection of reliable observations for Venus.

The past Eastern Elongation of Venus is one of these favourable ones that occur once in eight years. At Mount Florida, observations were commenced last December, and continued to the end of June, Venus being observed on 90 days, and 131 drawings were made in favourable definition by the Director, who considered this the best series of observations he has yet made of Venus; for the present Western Elongation, 36 drawings have been made. From a general consideration of these observations, and from micrometer measures of the terminator shading, the following preliminary conclusions are deduced, viz.:—

1. The gaseous envelope surrounding Venus is between 400 and 500 miles deep.
2. The upper strata of this envelope is free from clouds while the lower strata is probably free from clouds, but it is misty.
3. The solid surface of Venus is seldom, if ever, seen.
4. The planet has a quick rotation, *i.e.*, similar to the earth's rotation period.
5. The exact, or even approximate, duration of this rotation period is very difficult to ascertain.
6. The direction of Venus's rotation is the same as the other planets, namely, from west to east.
7. The inclination of the axis of rotation is about 60° to the plane of Venus's orbit; the north pole of this axis was exposed to the sunlight during the months of January, February, and March of 1900.

The observations of Mercury are not nearly so numerous or complete as that of Venus. And the notes and drawings in the Director's possession do not point to any approximate conclusion regarding that planet.

Zodiacal Light Section.

Many important observations have been sent in by several of the Members of this Section, especially by Mr. Bayldon, but owing to the pressure of official duties and of other astronomical work, the Director has not been able to cope with these observations. He has, therefore, induced Mr. H. O. Barnard, with whom he has thoroughly discussed the subjects, to take temporary charge of the Section, and to discuss the observations already sent in.

III.—The Library.

Although the additions during the present Session are, numerically, somewhat less than those of preceding Sessions, they are far from being inferior in value and importance. Advantage was taken last autumn of an unexpected opportunity of acquiring several books on exceptional terms, and some of our Members—to whom the thanks of the Association are gratefully accorded—have generously presented records of their labours. Among these, attention may be specially directed to Sir William Huggins' Atlas of Representative Stellar Spectra, the second volume of Dr. Roberts' Photographs of Star-clusters and Nebulæ, Mr. Wilson's Astronomical and Physical Researches made at Daramona, the first volume of the publications of the Yerkes Observatory, containing particulars of all Mr. Burnham's Double Stars, and the fourth part of the Atlas of the Moon from the Paris Observatory. We are indebted also to several publishers who have kindly forwarded us copies of Astronomical works. The library now contains upwards of a thousand volumes and tracts, many of the latter being bound together in volumes, according to subjects. A complete list of the additions — presentations, purchases, and exchanges—up to June 30 will be found on pp. 416–418.

During the Session 134 volumes have been borrowed by Members, showing an increase on all previous Sessions.

A copy of the rules and a library card can be obtained by intending borrowers from the Hon. Librarian, who will also, on receipt of 1*s.* 1*d.*, forward a copy of the catalogue and the supplementary lists, or the latter alone at a *pro rata* charge.

IV.—Lantern Slide Department.

There are now in the Association's collection 1,626 lantern slides, being 111 more than the number reported last year, 13 only of the increase having been made for Members borrowing, the remainder having been presented, &c.

The number of borrowings, and consequently of slides circulated during the Session has slightly fallen off, the number of separate borrowings having been 59, against 70 in the Session preceding. The slides to the number of 1,958 were used by 42 borrowers, four more than last year, of whom 30 borrowed once, nine twice, two three times, and one five times. The amount received for the hire of these was 11*l.* 14*s.*

It will thus be seen that although the number of slides circulated, and the number of borrowings, was rather less, they were used by more Members, and the usefulness of the department was to that extent increased, and its popularity shown to be unimpaired.

V.—Eclipse Committee.

The Eclipse Committee have to report the completely successful results of the expeditions which went to observe the total eclipse of May 28, 1900. Though the project of a special steamer for the exclusive use of the members of the expedition fell through, from the fact that the "Tagus," the steamer which the Royal Mail Steamer had offered for the expedition, was requisitioned as a transport, yet they believe that the Association was not materially the loser thereby, inasmuch as a large number of Members organised small independent parties to various stations, some of which might have been otherwise neglected.

The stations, proceeding from the most westerly, were Wadesborough (N. Carolina), Ovar (Portugal), Plasencia, Navalmoral, Manzanares, and Elche (all in Spain), and three or four parties in or near the city of Algiers. There was, moreover, one point of observation at sea, in the Atlantic, off the coast of Portugal. All the observers, without exception, were favoured with fine weather.

The results of the expeditions are in the hands of the Committee, and a report is in course of preparation which will be issued before the end of the year by Messrs. Witherby & Co. in a volume uniform with "The Indian Eclipse, 1898." The price to Members of the Association will be 5*s*. net, carriage or postage extra. It will be illustrated by about 60 plates and photographs.

VI.—Branches.

North-western Branch (Manchester).

This Branch has now completed its Ninth Session, and the work of the year, pursued along the characteristic lines, under the valued guidance of Prof. Core, M.A., has been productive of steady progress. The Session was opened by a lecture from Miss Gertrude Bacon on the Indian eclipse and its lessons, in which was given an interesting and racy description of the incidents of the journey and of the eclipse, as viewed by Miss Bacon at Buxar. The lecture was much appreciated by a full gathering of Members and friends. The papers and other contributions, in some instances the result of personal research, submitted at the subsequent monthly meetings, necessarily addressed to smaller audiences, have proved both helpful and interesting. A fine lantern recently acquired by the Branch is an important adjunct to its general equipment. The membership maintains its former standard despite the unavoidable losses incidental to deaths and removals. The Branch again expresses its sense of indebtedness to the Parent Society and to the Directors of Sections for help in making the meetings attractive.

East of Scotland Branch (Edinburgh).

This Branch has now completed its Fourth Session, and the year just expired has, on the whole, been a satisfactory one. The lectures were arranged at the beginning of the Session in the form of a syllabus, and the programme proposed was on every occasion carried through. These lectures proved most interesting, and drew a good attendance of Members. The admission of Associates, sanctioned by the parent Society, has had a good effect upon the attendance. A handsome and useful lantern was purchased for the use of the Branch, and has been frequently used during the Session. A visit was paid to the City Observatory in March, and a very pleasant and instructive evening spent. The sky was clear at intervals, and various celestial objects, including the moon and Venus, were viewed through the telescopes. The funds of the Branch are in a satisfactory state.

VII.—Instruments belonging to the Association.

The following instruments have been presented to the Association since its foundation. As the Association does not yet possess an observatory, they are in the charge of the several Members mentioned below:—

1. Photographic telescope, 4 inches aperture. Presented by Mr. G. E. Niblett. Lent to Mr. Walter Maunder for use in the eclipses of 1896 and 1900.
2. Silver-on-glass reflector, 18 inches aperture, with stand. Presented by the late Mr. N. E. Green, F.R.A.S. In the care of the Rev. J. M. Bacon, M.A.
3. Portable transit instrument, 2 inches aperture, by Dollond. Presented by Mr. Tyson Crawford, C.C. In the care of the donor.
4. Achromatic telescope, 3 inches aperture, with small tripod table stand, and wooden tripod garden stand. Presented by Mr. G. T. Davis. Lent to Miss M. A. Orr.
5. Equatorially-mounted achromatic telescope, 3½ inches aperture, with driving clock. Bequeathed by the late Miss E. Brown, F.R.Met.S. In the care of Miss J. E. A. Brown.
6. The observatory covering No. 5. Bequeathed by the late Miss E. Brown, F.R.Met.S. In the care of Miss J. E. A. Brown.
7. Grating spectroscope for attachment to No. 5. Bequeathed by the late Miss E. Brown, F.R.Met.S. In the care of Miss J. E. A. Brown.
8. Astronomical clock. Bequeathed by the late Miss E. Brown, F.R.Met.S. In the care of Miss J. E. A. Brown.
9. Achromatic telescope, 3½ inches aperture, with portable equatorial tripod stand. Presented by the Rev. Canon Edmund Carr, F.R.M.S., F.R.Met.S. In the care of Messrs. Troughton and Simms.
10. Quadrant, made by J. and E. Troughton for Sir Geo. Shuckburgh, Bart., F.R.S. (*circa* 1790). Presented by Capt. W. Noble, J.P., F.R.A.S., who received it from his granddaughter, Lady Katherine Harcourt. In the care of the donor.

THE BRITISH ASTRONOMICAL ASSOCIATION.

DR. REVENUE ACCOUNT FOR THE SESSION

	£ s. d.	£ s. d.
To the Association's "Journal" and "Memoirs" expenses:— Printing and posting No. 9, Vol. IX., and Nos. 1 to 8, Vol. X., of the "Journal," and Part 4, Vol. VII., Parts 2, 3, and 4, Vol. VIII., and Parts 1 and 2, Vol. IX. of the "Memoirs," List of Members, &c.	454 2 6	
„ Ditto, estimated and owing for No. 9, Vol. X., of the "Journal."	40 0 0	
	494 2 6	
„ Less amount reserved in Account for Session 1898–99	80 0 0	
		414 2 6
„ Rent of Hall for Meetings, and other expenses connected therewith.	—	32 2 0
„ Stationery and miscellaneous printing	—	18 19 9
„ Postages other than those connected with the "Journal" and "Memoirs."	—	23 14 5
„ Salary of Assistant Secretary	—	60 0 0
„ Insurance of stock of publications at printers, and of books, instruments, &c. at Sion College.	—	2 7 0
„ Cheque books and bank charges	—	0 9 5
„ Library Account:— Purchase of books, binding, &c.	—	11 9 6
„ Sundry petty expenses	—	2 0 1
„ Allowance for depreciation written off Stock of Publications Account (15 per cent. on 295*l.* 14*s.* 0*d.*)	—	44 8 0
„ Reserve Account:— Amount added thereto this Session	—	40 0 0
„ Balance down to Revenue Account:— Excess of Revenue over Expenses this Session	—	59 8 2
		709 0 10

This Revenue Account has been compared with the books and vouchers in the hands of the Treasurer, and is in accordance with them.

THE BRITISH ASTRONOMICAL ASSOCIATION.

OCTOBER 1ST, 1899, TO SEPTEMBER 30TH, 1900. CR.

	£ s. d.	£ s. d.
By Sundry Subscriptions as under:—		
85 Life Members (97 less 12 deceased) elected during previous Sessions.	--	
4 new Life Members at 6l. 6s.	25 4 0	
930 Ordinary Members at 10s. 6d.	488 5 0	
42 Ordinary Members paid in advance (amount brought forward from Sessions 1897–98 and 1898–99).	22 1 0	
107 Ordinary Members in arrear	56 3 6	
		591 13 6
1,168 Members—9 deceased = 1,159 Members, as per printed list.		
By 7 Subscriptions for Session 1897–98, paid up	3 13 6	
" 33 Subscriptions for Session 1898–99, paid up	17 6 6	
	21 0 0	
Less amounts credited in previous Accounts	21 0 0	
" Arrears of subscriptions previously written off, paid up.	—	1 11 6
" 81 Entrance Fees, at 5s.	20 5 0	
" 3 Entrance Fees in arrear	0 15 0	
		21 0 0
" 81 Members elected during Session		
" 2 Entrance Fees in arrear, paid up	0 10 0	
Less amount credited in previous Account	0 10 0	
" Sale of "Journals," "Memoirs," and reprints	31 15 10	
" " " " " " due	7 16 6	
	39 12 4	
Less amount credited in previous Account	5 7 0	
		34 5 4
" Sundry Donations to the General Fund	—	1 11 6
" Interest on Deposit Account	—	12 7 2
" Library Account:—		
Sale of Catalogues	1 6 6	
Fines	0 4 6	
		1 11 0
" Lantern Slide Department:—		
Hire of slides, &c.	13 2 9	
Sale of catalogues	1 14 0	
	14 16 9	
Less cost of making slides, printing, postage, and Messrs. Dollond's charges.	9 3 0	
		5 13 9
" Balance of excesses over deficiencies in foreign remittances.	—	0 2 9
" Subscriptions received in advance for Session 1900–1	23 12 6	
" " " 1901–2	2 2 0	
" " " 1902–3	1 1 0	
Entrance Fee received in advance for Session 1900–1	0 5 0	
	27 0 6	
Less amount carried forward to next Account	27 0 6	
" Remittances received in advance from Members awaiting election.	3 17 6	
Less amount carried forward to next Account	3 17 6	
" Balance down:—		
19,358 copies of "Journal," and 7,380 copies of "Memoirs," valued at cost of paper and printing.	324 4 1	
Less depreciation written off last Session	28 10 0	
	295 14 1	
Less value of Stock, September 30, 1899	256 9 9	
		39 4 4
	£	709 0 10

(Signed) HENRY ELLIS, GORDON MILLER } *Auditors.*

October 4, 1900.

THE BRITISH ASTRONOMICAL ASSOCIATION.

DR. GENERAL REVENUE

		£ s. d.	£ s. d.
1900.	To Arrear of Subscription for Session 1896–97, written off.	—	0 10 6
	„ Sundry Arrears of Subscription for Session 1897–98, written off.	—	4 14 6
	To Sundry Arrears of Subscription for Session 1898–99, written off.	—	4 14 6
	„ Balance down - -	—	174 13 2
		£	184 12 8

DR. BALANCE SHEET,

	£ s. d.	£ s. d.
To Sundry Subscriptions received in advance :—		
For Session 1900–1901 - - -	24 3 0	
„ „ 1901–1902 - -	2 2 0	
„ „ 1902–1903 - - -	1 1 0	
		27 6 0
„ Entrance Fee received in advance -	—	0 5 0
„ Remittances received in advance from Candidates for Election.		3 17 6
„ Remittance in hand, unappropriated -	—	0 7 3
„ Estimated cost of printing and issuing No. 9, Vol. X., of the "Journal."	—	40 0 0
„ Sundry Donations to the Observatory Fund	—	159 13 0
„ Balance held in Trust for the Eclipse Committee.	—	0 6 8
„ Reserve Account (contingent liability to Life Members) :—	460 0 0	
Added thereto during Session 1899–1900	40 0 0	
		500 0 0
„ General Revenue Account :— Balance, September 30, 1900 - -	—	174 13 2
	£	906 8 7

This Balance Sheet has been compared with the books and documents in the hands of the Treasurer, and is in accordance with them.

THE BRITISH ASTRONOMICAL ASSOCIATION.

ACCOUNT. CR.

		£ s. d.	£ s. d.
1899. Sept. 30	By Balance brought down - -	—	125 4 6
1900. Sept. 30	„ Balance from Revenue Account to this date.	—	59 8 2
		£	184 12 8

SEPTEMBER 30, 1900. CR.

	£ s. d.	£ s. d.
By Sundry Subscriptions in arrear :— For Session 1897–98 - - -	0 10 6	
„ „ 1898–99 - - -	15 4 6	
„ „ 1899–1900 - - -	56 3 6	
		71 18 6
„ Sundry Entrance fees in arrear - -	—	0 15 0
„ Amount due from Messrs. Eyre and Spottiswoode for "Journals" and "Memoirs" sold.	—	7 16 6
„ Stock of "Journals" and "Memoirs" in hand, taken at cost of paper and printing, less previous allowance for depreciation.	295 14 1	
Less allowance for depreciation this Session as per Revenue Account.	44 8 0	
		251 6 1
„ Bookcases, Sundry Books, Photographs, and Instruments (including optical lantern and accessories), &c. unvalued.	—	—
„ Cash at Bankers—Deposit Account - -	500 0 0	
„ Cash at Bankers—Current Account -	61 10 6	
„ Cash in hands of Treasurer - -	12 16 10	
„ Stamps in hands of Treasurer - -	0 5 2	
		574 12 6
	£	906 8 7

October 4, 1900. (Signed) HENRY ELLIS, GORDON MILLER } *Auditors.*

Reports of the Branches.

NEW SOUTH WALES BRANCH (SYDNEY).

The monthly Meeting of the Branch was held on Tuesday evening, March 23rd, at the rooms, Queensland Chambers, Bridge Street. The President (Rev. Dr. Roseby, F.R.A.S.) occupied the chair, and there was a good attendance. Mr. Hugh Wright read an interesting paper on "The Southern Cross," in which he traced, through the writings of numerous travellers, the identity of the constellation back to the year A.D. 1500. Dante's astronomy and allusion to the Cross were also dwelt on; and the occurrence of the configuration in the myths of the aborigines of Mexico and Australia was mentioned. The principal objects of interest in the constellation were pointed out, and a list of the double stars, variable stars, and clusters was supplied for the use of possessors of telescopes. Mr. C. J. Merfield, F.R.A.S., gave an account of his work in connexion with comets Coddington and Swift. Mr. W. J. Macdonnel, F.R.A.S., exhibited two very old astronomical volumes. The meeting concluded with an exhibition of lantern slides.

The usual monthly Meeting of this Branch was held at the rooms on Tuesday evening, April 17th, at 8 p m. The President, Rev. Dr. Roseby, F.R.A.S., occupied the chair. There was only a small attendance owing to the meeting night coming just after the Easter holidays.

The President delivered an interesting address on current astronomical literature, and drew attention to various articles in the "Journal," and to papers such as "Astronomy without a Telescope," &c., in other publications. Dr. Roseby's addresses are a feature of each meeting, and prove very acceptable to those present.

Mr. C. J. Merfield, F.R.A.S, spoke in connexion with his computation of the elements of the comet Swift, and a general discussion was entered into.

The meeting closed at 9.30 p.m.

The ordinary monthly Meeting was held in Sydney on June 19th, at which there was a large attendance. The ordinary business having been disposed of, a lecture was given by the President (Rev. Dr. Roseby, F.R.A.S.), on the "Star-Depths," and some Recent Questions in Astronomy. The lecture was illustrated by a number of diagrams, and concluded with a spectroscopic demonstration. The lecturer gave some account of the magnitude of the stellar system, and of the enormous distances of the remoter members of it from the earth. He said that the stars were suns, and to form some idea of what these suns were (thousands of millions in number) he first discussed the constitution and history of the sun. He dwelt particularly on the

spectroscopic features of the subject, pointing out how the stars had been classified. He then dealt with the origin and history of the planetary system, of which our sun was the centre. He treated the topic specially in connexion with the question of the possibility of life in other worlds. He pointed out that neither Jupiter nor Saturn offered such physical and climatic conditions as rendered such life as we are familiar with possible on their surfaces. But he directed closer attention to the planet Mars. He indicated in general that the idea of sentient and intelligent life being confined to our earth seemed antecedently improbable in view of the very insignificant contrast which our earth—a mere grain of earth as it were—presented to the vastness of the stellar universe to which it belonged. The lecturer's reference to Mars began with the remarkable discoveries of Schiaparelli, which for many years were treated with distrust, but were fully confirmed on the last occasion when the planet was favourably situated for observation by scores of other skilled observers, and especially by the splendid work of the Lowell Observatory in Arizona. The lecturer summed up his discussion of the question by quoting the recent testimony of the ex-president of the Royal Astronomical Society (Sir Robert Ball), who stated that, having carefully studied the problem, and having tested Mr. Lowell's facts and figures in every way, he (Sir R. Ball), with most astronomers, had come to the conclusion that, however astonishing the observations were, we could not refuse to accept them, and that they could be explained in no other way than by supposing that the straight lines on the face of the planet Mars indicated the working of an intelligent purpose. If we met with such operations on our own earth (continued this distinguished astronomical authority) we should, without hesitation, conclude that they were conducted under rational guidance. The lecturer, among a mass of other evidence which he adduced, made special reference to the useful work done by the "Mars" Section of the British Astronomical Association, and showed, from the Chart of Mars prepared from observations of the Section in 1896, how marked was its concurrence with that of the great observatories of Milan and Arizona. He quoted the remark of the Director of the Section that the last favourable opposition of the planet "seemed to have fully demon-" strated the accuracy of Schiaparelli's observations and maps." The lecturer concluded with a reference to the sublimity and suggestiveness of the science, which it was the business of their society to study. On the motion of Mr. T. F. Furber, F.R.A.S., a hearty vote of thanks to Dr. Roseby concluded the proceedings.

VICTORIA BRANCH (MELBOURNE).

The Fourth General Ordinary Meeting of the Branch was held at Broken Hill Chambers, 31, Queen Street, Melbourne, on Thursday the 7th June 1900, at 8 p.m. The Rev. J. Meiklejohn, M.A., President, in the Chair.

After the usual formal business of the Meeting had been dealt with, Mr. Wigmore entertained Members by giving a Practical Demonstration of the Art of Grinding and Polishing Glass Specula. In brief compass, he illustrated the whole compass from

start to finish, and with such clearness, that all present felt edified. By special request the lecturer was asked to continue his subject and show how testing and silvering were done, this was agreed to, if practicable, on some future occasion.

The President conveyed to Mr. Wigmore the thanks of the Meeting.

The Fifth General Ordinary Meeting of the Branch was held at the University, Melbourne, on Thursday the 5th July at 8 p.m. The Rev. J. Meiklejohn, M.A. (President) in the Chair.

After the usual formal business had been dealt with, Mr. T. W. Fowler, M.C.E., F.R.G.S., brought Members and friends over the newly erected Observatory and Engineering School of the University with the various instruments in use. Thereafter, he entertained his audience by exhibiting on the screen a large number of astronomical slides as well as slides showing meteorological stations, also Victorian scenery of a most interesting character.

On the Saturday following, some 25 to 30 Members and friends availed themselves of an opportunity of visiting the Melbourne Observatory. The 8-in. equatorial was made use of under favourable weather conditions.

The Society feel grateful to Mr. Fowler and Mr. Barrachi for two most enjoyable evenings.

The Sixth General Ordinary Meeting of the Branch was held at the Board Room, Broken Hill Chambers, 31, Queen Street, Melbourne, on Thursday the 2nd August 1900, the Rev. J. Meiklejohn, M.A., President, in the Chair.

The Secretary read a communication from Mr. W. F. Denning, F.R.A.S., Bristol, upon Meteor Radiant Research, advocating co-operation from Members of the "Victoria Branch." Mr. Barrachi spoke words of encouragement to forward this section of the work. Mr. Love referred to the large amount of work accomplished by Mr. Denning in meteor observation It was agreed to have the communication printed and circulated amongst Members.

Mr. Byatt received a hearty welcome as coming from the parent Society.

Mr. Gillespie (Vice-President), took the chair while the President delivered a most interesting lecture on Laplace and the Nebular Hypothesis. The Lecturer gave a short sketch of Laplace's work, stated the main facts connected with the history of the Nebular Hypothesis, and reviewed the various objections which had been urged against it. An interesting discussion followed in which the chairman and several Members took part. Mr. Baracchi illustrated the subject by slides thrown on the screen, showing that Nebula assumed all sorts of shapes and forms.

A vote of thanks was accorded to the President by Mr. Macdonald and seconded by Mr. Love. Carried with acclamation.

Papers communicated to the Association.

Observations des taches de Jupiter, 1899.

Par M. le Prof. J. Comas Solá.

Je me propose dans ce résumé donner compte principalement des mouvements que j'ai pu observer dans les taches principales de la planète. Mes observations sont commencées le 18 février et terminées le 8 juillet, mais elles furent interrompues pendant le mois de mars. L'instrument employé a été l'équatorial double Mailhat de 8 pouces et demi et les grossissements ont varié, en général, entre 160 et 260.

La bande équatoriale boréale, qui était simple l'année dernière avec des taches éparses au N., s'est faite, pendant l'opposition actuelle, completement double. La coloration rougeâtre des deux bandes équatoriales a été semblable et pas très intense.

Dans les calculs suivants de rotations ont entré toutes les observations de passages, exceptuant seulement les observations d'estime (indiquées par le double signe ±) faites hors du méridien central et reconnues de très faible poids, du même que les observations se rapportant à des taches d'identification douteuse. Pour le calcul, j'ai formé deux groupes de moyennes, initiale et finale, et de poids le plus semblable possible. En total, j'ai fait 218 observations de passages.

Taches de la zone équatoriale.—Bord N. de la bande équatoriale australe.

		°	
Tache I.	20 avril	9·4	Tache foncée, petite, et suivie d'un chapêlet de taches plus petites et foncées dans le mois d'avril. Simple et plus visible depuis. Rot. = $9^h\ 50^m\ 24^s$.
	27 „	5·4	
	29 „	4·6	
	20 mai	358·8	
	31 „	4·9	
	7 juillet	9·7 (?)	
„ II.	27 avril	42·0(?)	Blanche, brillante, quelque fois double. Les taches doubles sont pointeés toujours au milieu. Rot. = $9^h\ 50^m\ 25^s$.
	31 mai	25·6	
	12 juin	32·3	
	7 juillet	25·0	
„ III.	12 juin	53·0	Foncée. Observations d'estime acceptables. Rot. = $9^h\ 50^m\ 14^s$.
	5 juillet	47·6 ±	
	7 „	40·2 ±	
„ IV.	23 avril	71·8	Blanche. Observations insuffisantes pour le calcul de la rotation avec quelque exactitude.
	27 „	66·2	
„ V.	11 mai	75·1	Blanche, très brillante quelque fois double. Rot. = $9^h\ 50^m\ 22^s$.
	16 „	79·1	
	19 juin	70·7	
	5 juillet	65·8	
„ VI.	9 mai	90·5	Foncée, bien visible, avec trainée la réliant à la tache I. Rot. = $9^h\ 50^m\ 26^s$.
	11 „	86·1	
	16 „	86·5	
	12 juin	80·5	
	19 „	86·6	
	5 juillet	81·1	

Tache VII.	21 avril	135°·1	Blanche, souvent double. Rot. = 9h 50m 28s.
	28 „	112·6±	
	30 „	114·2	
	9 mai	121·0	
	16 „	116·9	
	1 juin	112·2	
	5 juillet	100·0 (?)	
„ VIII.	21 avril	128·8	Foncée, grande, avec des trainées. Rot. = 9h 50m 23s.
	28 „	129·1	
	30 „	126·3	
	9 mai	128·5	
	16 „	122·4	
	1 juin	120·7	
„ IX.	28 avril	140·0	Blanche, peu apparente, double le 28 avril. Observations insuffisantes.
	30 „	132·4	
„ X.	30 avril	144·6	Foncée. Seule observation.
„ XI.	10 mai	212·4	Blanche, simple. Rot. = 9h 50m 23s.
	19 „	212·0	
	28 „	213·7	
	30 „	210·9	
	6 juin	207·3	
	6 juillet	207·0	
„ XII.	1 mai	222·6	Foncée, souvent sous la forme d'une tache allongée formée de petites taches, avec large trainée. Dernierement, simple et petite. Rot. = 9h 50m 20s.
	10 „	224·6	
	19 „	223·5	
	6 juin	213·4	
	6 juillet	217·9	
„ XIII.	1 mai	244·6	Blanche, de grandes dimensions. Observations insuffisantes.
	10 „	231·3	
„ XIV.	10 mai	241·1	Foncée. Seule observation.
„ XV.	10 mai	252·7	Blanche. Double le 19 juin. Rot. = 9h 50m 15s.
	19 „	244·8	
	6 juin	239·0	
	6 juillet	231·3	
„ XVI.	7 mai	268·2	Foncée, bien apparente. Rot. = 9h 50m 18s.
	10 „	269·1	
	17 „	266·5	
	19 „	264·9	
	2 juin	261·2	
„ XVII.	20 avril	299·9	Blanche, souvent double, très brillante et de grandes dimensions. Tache très importante. Rot. = 9h 50m 15s.
	29 „	293·3	
	1 mai	288·4	
	10 „	281·9	
	15 „	286·7	
	17 „	280·5	
	19 „	277·1	
	31 „	280·1	
	2 juin	276·8	
	6 „	268·6	
	9 „	276·5	
	18 „	276·5	
	4 juillet	268·6	

Tache XVIII.	29 avril	303°·2	Foncé, très visible. Rot. = 9h 50m 22s. Les remarques sur les taches XVII., XVIII. et quelques autres on peut les trouver, en partie, dans "Astr. Nach.," No. 3583; les restantes seront publiées prochainement dans la même Revue (elles ont été publiées dans le No. 3596).
	1 mai	299·3	
	10 „	296·9	
	15 „	294·7	
	17 „	292·7	
	19 „	289·3	
	31 „	292·3	
	2 juin	291·1	
	6 „	289·3	
	9 „	289·3	
	18 „	287·5	
	4 juillet	286·2	
„ XIX.	29 avril	314·1	Blanche, brillante et double. Rot. = 9h 50m 24s.
	31 mai	303·8	
	2 juin	303·9	
	3 „	300·9	
	18 „	304·5	
„ XX.	15 mai	321·5	Foncée. Rot. = 9h 50m 44s. Observations de faible poids.
	31 „	316·6	
	3 juin	324·6	
„ XXI.	15 mai	336·1	Foncée. Rot. = 9h 50m 30s.
	31 „	336·2	
„ XXII.	20 avril	354·8	Blanche, quelque fois double. Rot. = 9h 50m 21s.
	29 „	348·2	
	15 mai	348·9	
	31 „	349·0	
	3 juin	342·9	

Bord N. de la zone équatoriale. Les taches de ce bord ont éte en général sombres, diffuses, très variables et éphemères.

Tache 1	23 avril	82°·7	Foncée. Rot. = 9h 49m 34s (très faible poids).
	27 „	77·2	
	11 mai	53·2(?)	
„ 2	21 avril	97·0	Blanche. Rot = 9h 50m 30s.
	23 „	101·1	
	30 „	98·5	
	9 mai	95·4	
	11 „	104·4 ±	
	16 „	96·8	
„ 3	21 avril	114·2	Foncée. Rot. = 9h 50m 19s.
	23 „	119·3	
	30 „	114·2	
	9 mai	112·5	
„ 4	30 mai	193·3	Claire, longue. Rot. = 9h 50m 37s.
	6 juin	192·1	
	8 „	199·0	
„ 5	1 mai	231·8	Foncée, penombrale. Rot. = 9h 50m 2s.
	10 „	224·6	
	30 „	210·9	

Tache 6	10 mai	$252°·2$	Blanche, longue, puis petite. Observations d'estime acceptables. Rot. = $9^h\ 50^m\ 53^s$.
	17 „	$260·4±$	
	19 „	$263·1±$	
	2 juin	$265·2$	
„ 7	1 mai	$262·1$	Foncée. Rot. = $9^h\ 50^m\ 21^s$.
	10 „	$260·6$	
	2 juin	$255·1$	
„ 8	1 mai	$282·3$	Foncée. Identification douteuse.
	10 „	$272·1$(?)	
„ 9	10 mai	$300·2$	Foncée. Rot. = $9^h\ 49^m\ 46^s$ (très faible poids).
	17 „	$292·7$	

Rotation moyenne des taches du bord S. de la zone équatoriále $= 9^h\ 50^m\ 23^s·35$.

Rotation moyenne des taches du bord N. de la zone équatoriále $= 9^h\ 50^m\ 15^s·25$.

Rotation moyenne de la matière de la zone équatoriálo $= 9^h\ 50^m\ 20^s·76$.

Taches dans la composante boréale de la bande équatoriále boréale.

Tache A.	27 avril	$52°·0±$	Foncée. Rot. = $9^h\ 55^m\ 46^s$.
	29 „	$56·0$	
	11 mai	$57·6$	
„ B.	9 mai	$53·4±$	Région claire. Rot. = $9^h\ 55^m\ 35^s·7$.
	11 „	$66·6$	
	16 „	$63·3$	
	28 „	$65·5$	
	30 „	$61·7$	
	9 juin	$60·4$	
„ C.	27 avril	$77·8$	Foncée, presque noire. Rot. = $9^h\ 55^m\ 34^s·4$.
	29 „	$75·2$	
	11 mai	$74·5$	
	16 „	$72·4$	
	28 „	$74·0$	
	30 „	$70·1$	
	9 juin	$68·3$	
„ E.	20 avril	$180·9$	Foncée, protuberance boréale de la bande. Rot. = $9^h\ 55^m\ 18^s·5$.
	27 „	$170·2$	
	19 mai	$160·4$	
	31 „	$155·9$	

Rotation moyenne des taches de cette zone.—$9^h\ 55^m\ 33^s·62$.

Taches dans la zone Tropicale N.

Tache D.	20 avril	$155°·6$	Blanche très brillante avec une tache foncée allongée au N. Rot. = $9^h\ 55^m\ 32^s$.
	27 „	$150·3$	
	19 mai	$147·1$	
	31 „	$145·0$	

Tache F.	20 mai	320°·1	Blanche très brillante. Rot. 9^h 55^m $43^s·6$.
	1 juin	321·9	
	6 „	321·3	
	8 „	320·1	
	18 „	319·5	
Tache A. Dans la bande temperée boréale.	30 mai	6·1	Foncée, difficile. Lat. = + 30°. Rot. = 9^h 55^m 23^s.
	6 juin	3·0	
Tache A_1 Dans la bande temperée australe.	31 mai	174·6	Foncée, petite. Lat. = −26°. Rot. = 9^h 54^m 18^s.
	12 juin	170·2	
	6 juillet	155·2	
Tache A_2 36°.	10 mai	218·1 ±	Foncée, petite. Rot. = 9^h 55^m 10^s.
	17 „	217·3	
	31 „	204·8	

Tache rouge.—A peine visible. Mes observations se rapportent à la pointe foncée orientale.

	29 avril	47°·0
	11 mai	48·5
	16 „	49·4
	30 „	47·1
	6 juin	46·5
	6 „	52·0
	4 juillet	45·3
Moyennes	28 mai	47·97

Durée moyenne de la rotation depuis le mois de mai 1898, 9^h 55^m $41^s·85$.

Latitudes des bandes équatoriáles.—Trois séries de mesures micrométriques, faites les 1 mai, 8 juin et 7 juillet, m'ont donné résultats suivants.

—	Bande équatoriale australe.	Bande équatoriole foréale.
1 mai 1899	− 9° 31′	+13° 56′
8 juin „	−10 9	+10 28
7 juillet „	−14 10	+11 18
Moyennes 5 juin	−11 17	+11 52

Ces longitudes se rapportent au milien des bandes et à la sphère de rayon égal au demi-diamètre polaire de Jupiter.

Correspondence.

Occultation of Saturn by the Moon, September 3, 1900.

The sky was clear, and definition good, excepting for a somewhat fluctuating image of Saturn occasioned by neighbouring houses. The details of the planet were clearly visible at still moments, the shadow on the ring being well seen, and Cassini's division at the ends of the ansæ. The colour of Saturn, as seen before occultation, was a dull, rather ruddy orange in contrast with the pale brilliant gold tint of the moon.

At the moment of the commencement of occultation the apex of the ansæ nearest the moon became suddenly flattened obliquely to the long axis of the ring's ellipse. The black opaque clearly defined edge of the dark limb of the moon advanced gradually across the planet, cutting across successively the rings, the space between the ball and the rings, and then the ball itself, and finally the further space and ansæ, like a great black screen with a slanting edge.

There was no trace of projection of any part of the planet upon the moon, and no penumbra or extension of light upon the dark line of the moon's limb.

The edge of the limb was apparently even, and was well-defined. The several features of the planet were successively covered without any diminution of their clearness or distortion of outlines.

At reappearance the lunar limb was "boiling," and the details of the successive uncovering of the planet were less distinctly observed than those of the occultation, but no abnormal appearances were seen.

The most striking peculiarity was the apparent change in the colour of the planet. Whereas previous to occultation the colour of the planet (as compared with that of the moon) had been noted as a dull and slightly ruddy orange; on its reappearance at the bright limb it appeared as little coloured as rough cast lead. The tint suggested grey painted wood unvarnished, and the effect was such as to suggest a small steel engraving by the side of a coloured picture. It was noteworthy that the definition of detail on the planet when in the immediate neighbourhood of the bright limb of the moon was exquisitely clear and sharp.

Titan was not seen either at immersion or reappearance.

The instrument used was a $2\frac{1}{10}$-in. achromatic, power 60.

With a more powerful instrument it would have been interesting to compare, both as to shape and blackness, the shadow of the planet on the rings with the lunar dark limb. Some observations on this will, it is hoped, have been made on the present occasion by observers using larger apertures.

15, German Place, Brighton. R. J. RYLE.

Occultation of Saturn by the Moon, 3rd September 1900.

I BEG to submit the following report of my observations:—

The southern portion of the sky was clear, but there was considerable light haze. Atmosphere still.

7 p.m.—I first observed Saturn through the binocular.

7.11 p.m.—It appeared through the binocular as more irregular than usual.

7.13 p.m.—Observed it through a 3-in. telescope; its appearance was distorted, half of the ring only being apparent.

7.14 p.m.—The planet was no longer visible. It seemed to disappear in a dull orange film of light, which I at first mistook for haze, and which may have been partly due to that cause, as I noticed later some light cloud just above the upper portion of the moon.

7.47 p.m.—Observed a light halo round the moon.

8.11 p.m.—First re-appearance of the planet through the light filmy haze of the halo.

8.15 p.m.—Halo round the moon visible through the binocular, but the planet itself was not visible through the halo.

8.17 p.m.—Form of planet dimly seen through the 3-in. telescope.

8.19 p.m.—Form of planet and both sides of the ring visible in a faint yellow film-like haze as seen in the 3-in telescope.

8.20 p.m.—I first observed the planet through the binocular. At no time did I observe any tinge of green on Saturn itself, either before or after occultation.

I enclose a rough sketch made at the time of observation.

Hillside Cottage, Aspley Guise, R.S.O., Beds, 4th September 1900. — WM. C. TETLEY.

Occultation of Saturn.

The occultation of Saturn was very well seen here by myself with a 3-in. refractor, and by another observer with a field-glass and the naked eye. Unfortunately, no exact measurement of times was possible. There was no earthshine apparent, and Saturn only became visible in the 3-in. about 10 minutes before immersion, owing partly to still strong daylight, and partly to light clouds or fog. The boundary of Saturn, when passing under the moon, appeared throughout a portion of the same circle as the boundary of the bright limb of the moon. There was nothing corresponding to the apparent projection on the dark body of the moon which I have noticed in occultations of Antares before disappearance. The naked eye observer said the star had disappeared when about half was still visible in the 3-in. telescope. I do not know whether these details are of any importance, at any rate, it was a very interesting sight.

Kidlington, Oxford. September 3, 1900. — W. STEADMAN ALDIS.

P.S.—Telescopic observation of the emergence was impossible owing to a row of pine trees which cut off my western view. A field-glass failed to show the planet until it was quite separated from the bright limb, which was not until about 8.13.

Red Stars.

I would like to ask Mr. Chambers a question. In his new catalogue of "Red Stars for 1900," I find α Eridani included and called "Red," which it most certainly is not. It is very pure white star, but perhaps at a low elevation a scintillation of red may twinkle out now and then, as is the case with every star bright enough to be seen near the horizon. The reason I query its inclusion is because Mr. Chambers says that he has only included those stars that have been reported in print as red "by "a fair concurrence of testimony." The authorities in this case might very well be cited, or some millions of years hence many pamphlets may be written on another change of colour in a bright star, as is already alleged in regard to Sirius.

Whilst on the subject of "Red Stars," might I draw attention to the condensed lists of such in Vol. III. of the Cape Photographic Durchmusterung, pages 12 and 13 of Sir David Gill's introduction. A few of the more noticeable are the following:—

——	1875.	Colour.
	h m s ° ′	
CZ 345	8 4 30 − 35 55	RR.
" 3,255	17 48 4 − 28 0	RR.
" 2,796	7 38 44 − 43 54	RRR.
CGA 14,047	10 12 31 − 49 28	RR.
T Lupi	14 14 5 − 49 16	RR.
CZ 2,768	16 39 38 − 44 40	RR.
" 1,214	17 17 53 − 40 6	RR.
Gilliss 4,619	7 7 53 − 72 49	RR (Var.)
CGA (35)	10 51 13 − 57 47	RR.
CZ 3,707	11 54 8 − 60 0	RRR.
" 246	15 3 42 − 59 52	RRR !!
R Fornacis	2 23 40 − 26 39	RRR.
Cor. DM	6 53 54 − 35 52	RR.
"	12 22 40 − 37 34	RRR !

These stars do not occur in the C. P. D. owing to their lack of actinic light.

In looking down the columns of the C. P. D., it will frequently be noticed that the photographed magnitude is much less than the visual. I have looked up many of these cases, and in all it is due to the colour (deep yellow to orange-red) of the star. A list will be published later on.

Cape of Good Hope,
22 August 1900.

R. T. A. INNES.

Cassini's Division of Saturn's Ring.

I have lately obtained some very favourable observations of Saturn with my 3-in. achromatic, using powers of 120 and 150, and have been struck by the fact that Cassini's division on the ring is almost invariably more distinctly marked on the preceding than on the following ansa. This greater distinctness with which the various divisions are sometimes traceable on the one ansa

rather than on the other, has been, I believe, often noticed, and in the cases I have so far come across, it has generally been the left ansa which exhibits the divisions more distinctly.

Among other observers, Herr Brenner says (Astronomische Nachrichten, 3450), he has seen "the divisions more distinct on the left than on the right ansæ," and in M. Antoniadi's beautiful drawing of the planet, as reproduced in the frontispiece to the second edition of Mr. Mee's "Observational Astronomy," Encke's division is marked with great distinctness on the left ansa, whereas it is scarcely visible on the right. I have so far seen no explanation offered of this difference in visibility, nor am I aware whether it is generally considered to be due to objective, or rather to subjective phenomena. In the case of my own telescope, which is mounted as an alt-azimuth, I can readily understand that, as the image of Saturn slowly transits the field of view, the light from the preceding ansa of the ring continually impinging upon fresh portions of the retina would cause any delicate markings on that ansa to be seen more vividly. This explanation, however, would scarcely apply in the case of a clock-driven equatorial, and it would be interesting to hear what has been the experience of other observers in this connexion.

34, Viale Principe Amedeo, Florence, July 17, 1900. W. ALFRED PARR.

The "Bursting Meteor" of September 19.

Having had the opportunity of seeing the "bursting meteor" or "shooting star" on the evening of September 19, 1900, possibly the following may be of interest:—

On the evening of September 19, at about 7 p.m., App. Ship Time, I was taking an observation of Polaris for latitude to work in conjunction with "α Bootis" for longitude; Chief Officer taking time by chronometer.

Whilst bringing down Polaris, a glare was mirrored in my sextant, and looking by direct vision, I saw the meteor shooting from near "R Ursæ Majoris" and disappearing near "β Camelopardalis," bursting twice upon its journey, once in about 70° Dec. N. and 8^h R.A., again in about 65° Dec. N. and 6^h R.A., and, finally, in about 58° N. Dec. and 5^h R.A.

It was the most brilliant of its kind that I remember seeing. The path was very brilliant and definite, interrupted by magnificent blue explosions. I called "time," and afterwards found Chief Officer had logged $19^d\ 7^h\ 29^m\ 40^s$, error $1^m\ 2{\cdot}3^s$ G.M.T. Ship's position was latitude 47° N. and longitude 7° 48′ W.; wind, light S.E.; smooth sea, with W.N.W. and N. swells; sky cloudless, with the last lights of twilight.

I could not help thinking how interesting a spectroscopic analysis of it would be. Possibly some Member more advanced, and with better opportunities of observing, may tell us something about it.

S.S. "Guillemot," 20th September 1900. F. W. RAISIN, 6, Reservoir Road, S.E.

Its motion, of course, was sub-polar, and during the latter part more curved in a southerly direction.

Notes.

The late Prof. James Keeler.—It came as a great grief and as a sudden shock to the many friends of Prof. J. E. Keeler on both sides of the Atlantic, to hear of his death on 1900, August 12. He was born at La Salle, Illinois, on 1857, September 8, and so was barely 43 years of age.

Prof. Keeler graduated at the Johns Hopkins University, and was initiated into astronomical work in the solar eclipse of 1878 in Colorado. Afterwards he went as assistant to the Allegheny Observatory, where he took part in Prof. Langley's bolometric investigations, especially in the expedition to Mount Whitney, where the bolometer probed the infra-red region of the spectrum. Then he went to study in Berlin and Heidelberg under Helmholtz and Quincke, and returned in 1885 to take up work at the newly established observatory on Mount Hamilton, in California. In May 1891 he went back to the Allegheny Observatory as its director. Here he took up astronomical photography, and showed how delicate were its powers by his photographic demonstration of the meteoric character of Saturn's rings. Here he also obtained photographs of the spectra of the red stars, and made an admirable series of drawings of Mars, published in the "Memoirs" of the Royal Astronomical Society. In 1898 he returned to the Lick Observatory as its director, and short as has been his time there, he has made it memorable by the beautiful photographs of nebulæ taken with the Crossley reflector.

He has been President of the Astronomical Society of the Pacific, and a Councillor of the Astronomical and Astro-Physical Society of America, an Associate of the Royal Astronomical Society, and a Member of the National Academy of Sciences. He has also been awarded the Draper and Romford medals.

He last visited England in the summer of 1896.

The Siege of Pekin.—We heartily congratulate our fellow member Prof. S. M. Russell, M.A., F.R.A.S., the Imperial Astronomer at Pekin, on having come through its siege in safety. It is, perhaps, too much to hope that his instruments have fared equally well. His first letter after that long silence—which those at home had scarcely ventured to hope was other than that of death—reached England on the first day of October. It was dated the evening of August 15, only an hour or two after the British troops had entered the Legations. Prof. Russell wrote, not merely in good spirits, but in a tone of evident self-congratulation at his good fortune in having had the opportunity of taking part in one of the severest sieges of history. Nevertheless, the exclusive diet of horse flesh and rice, on which the residents in the Legations had to sustain the siege, was not of so satisfying a nature as to induce Prof. Russell to unduly hesitate about going on a foraging expedition. A postscript gave his results as 20 chickens and 100 eggs.

The Telescope of the Future.—In his address as Chairman of the Department of Astronomy in Section A. of the British

Association, Dr. Common, after briefly reviewing the progress of astronomy during the last 70 years, and the history of the development of the telescope, advocated the use of a horizontal telescope directed towards a cœlostat. Such a telescope might be contained in a fan-shaped house moving on circular rails round the cœlostat in the centre, or a permanent house might encircle the mirror, and the telescope be so mounted as run round in this to any required azimuth. The simplicity of the arrangement and the enormous saving in cost would allow the construction of a special instrument for special work, and it is suggested that for lunar photography a special cœlostat, with adjustments for the polar axis and for regulating the driving-clock might be combined with a reflecting mirror of 200 feet focal length, giving an image of 2 feet diameter in the primary focus. In the new Paris telescope, the heliostat form of mounting has been adopted for the mirror, which gives a rotation to the image, but the object-glass is nearly 50 inches in diameter, representing a great advance over the Yerkes telescope; it may be some time before the glass can be obtained for a larger lens, but there would be little difficulty in making a concave mirror of 6 or 7 feet diameter. Such an instrument should be erected in a position giving the most favourable climatic conditions. Up to quite recently the silvering of large mirrors has been a tedious, expensive, and uncertain operation; now the surface can be renewed with less trouble than is involved in separating and cleaning the lenses of a large refractor.

"Knowledge Diary and Scientific Handbook."—Under the foregoing title, Messrs. Witherby & Co. are bringing out a diary for scientific workers. Amongst its contents are an Historic Summary of the Advance of Science in the Nineteenth Century; Astronomical Notes and Tables, with an account of the Astronomical Phenomena of the Year, and 12 Star Maps showing the Night Sky for every Month in the Year, with full descriptive account of the Visible Constellations and Principal Stars; Tables of Tides and Tidal Constants; Original Descriptive Articles on the Tides and Terrestrial Magnetism; a Calendar of Notable Events; Photograph and Detailed Description of the Gigantic Telescope exhibited at the Exposition Universelle in Paris, with a Table of Principal Observatories of the World; List of Principal Refractors of the World, and Monthly Astronomical Ephemeris.

In addition there is a blank diary portion for the year, giving a whole page to a day, with separate pages for Monthly Notes and Memoranda, Diary Index, and Cash Account, and many other tables and information usually found in diaries.

Prof. Saija.—The death is announced, on August 31st, at the early age of 36, of Guiseppe Saija, assistant at the Royal Astrophysical Observatory at Catania, and Professor of Nautical Astronomy at the Royal Technical and Nautical Institute there. (**Ast. Nach.**, No. 3663.)

The late Capt. C. Orde Browne, R.A.—"The death is announced of Capt. C. Orde Browne, R.A., who will be remembered as one of the observers of the Transit of Venus, 1874,

when he occupied the station at Mokattam, Egypt. His determination of the differences of longitude between Mokattam and Alexandria, and Mokattam and Suez are links in one of the longitude chains connecting Greenwich and Madras." (Obs., October.)

REPORT OF THE CAPE OBSERVATORY.—A new record room has been completed. The pier and foundations for the new transit circle are ready, but there is delay in obtaining the dome. The transit instrument has been employed in observing the standard stars for the astrographic plates. The 24-in. McClean photographic objective having been returned for re-figuring, the instrument has been used with the 18-in. visual objective for measuring 21 close doubles. The 7-in. equatorial has been used for revising the Cape Photographic Durchmusterung, observing suspected variables, and detecting new doubles. The 6-in. has been used with a Zollner photometer for determining visual magnitudes to be subsequently compared with the known photographic magnitudes. With the astrographic equatorial, 152 chart plates and 184 revision catalogue plates have been passed; 103 plates containing 38,785 stars have been measured, all observations showing an error of $0''\cdot6$ being repeated. 78 photographs of Iris were taken between July 11 and December 31, which are to be used in determining the mass of the moon. With the heliometer observations of oppositions of the major planets have been continued. The geodetic survey of South Africa and Rhodesia has been interrupted by the war, and the Anglo-German boundary survey hindered by the waterless character of the Kalihari Desert, but the work is completed as far as Arahoab. (Nat., August 23.)

STANDARDS FOR FAINT STELLAR MAGNITUDES.—Prof. E. C. Pickering announces a plan for the determination of standards by co-operation among several observatories. Five wedge photometers have been constructed, and 36 regions carefully selected in different parts of the sky. Five stars of each of the magnitudes 12, 15, 16, 17 are to be selected in each region. The faintest will be measured at Lick and Yerkes, those of magnitude 16 by the 26-in. of the University of Virginia, and, perhaps, the 23-in. Princeton refractor; those of magnitude 15 by the 15-in. Harvard telescope. All these are to be compared with stars of the 12th magnitude, whose absolute magnitudes will be determined with the Harvard 12-in. meridian photometer. (Nat., August 23.)

The Eclipse Report, 1900.

The Eclipse Committee have arranged with Messrs. Witherby & Co., the publishers of "Knowledge," to bring out the reports of the various eclipse parties of the British Astronomical Association in a volume to be uniform with "The Indian Eclipse, 1898." It will be a crown octavo volume of from 150 to 200 pages, and will be illustrated by 50 to 60 photographs and plates. The published price will be 7*s*. 6*d*., but Members of the Association will be able to procure it at 5*s*. net, exclusive of postage.

New Books and Memoirs.

Publications of Sir William Huggins's Observatory, Vol. I. An Atlas of Representative Spectra. By Sir William Huggins, K.C.B., and Lady Huggins. London: William Wesley & Son, and Hazell, Watson and Viney. 1899.

Some nine and twenty years ago Mr. Proctor dedicated his admirable book on the Sun to Dr. Huggins, "The Herschel of the Spectroscope." The title was a happily chosen one even then. For just as Sir William Herschel initiated almost every department of observation in sidereal astronomy, and laid its foundations, solid, broad, and deep, so in 1871 Sir William—then Doctor—Huggins had initiated almost every department of spectroscopic astronomy, and had accomplished a vast amount of most important work in each.

But to-day the title is far more appropriate to Sir William Huggins than when it was first given him. Sir William Herschel's great work was his attempt to fathom the structure of the sidereal heavens. The same great problem was first attacked with the weapons which the spectroscope and photography have supplied to us by Sir William Huggins, and he has carried on the inquiry further and more successfully than any other labourer in the same field.

The first volume of the publications of Sir William Huggins' Observatory show the great spectroscopist in both lights, namely, as the pioneer of every variety of spectroscopic astronomy, and as attacking from its spectrographic side the great problem of World Building.

The first chapter, the "History of the Observatory and the work done therein," is to a great extent a reprint of an article which appeared in the number of the "XIXth Century" for June 1897. No ordinary interest attaches to the record by the explorer himself of the first recognitions of known terrestrial elements in distant stars; in the first approximations of the equipment of an astronomer's observatory to those of a chemist's or a photographer's laboratory; whilst for the intensest scientific emotion it would be hard indeed to find a parallel to that memorable evening, August 29, 1864, when for the first time Dr. Huggins gazed upon the spectrum of a planetary nebula.

The story of the other achievements that followed, so numerous and so great, of T Coronæ, of the motion of stars in the line of sight, of the carbon spectrum in comets, of the solar hydrogen prominences seen in full sunshine, of the rhythmic group of hydrogen lines in the ultra-violet region of the white stars, told by the man who was the leader in every one;—such is the first chapter of this book.

Chapter II. forms a fitting sequence to it. It is the list of published papers —over 80 in number—on the work done in the observatory, and the design for its initial letter is, appropriately enough, a beehive in the garden with the motto *Nil nisi labori*. This initial letter and the corresponding initials at the commencement of the other chapters are all drawn and designed by Lady Huggins. For the book is, as far as possible, in appearance from the dull repulsiveness too commonly characteristic of observatory reports. It is a beautiful book; the broad margins, the thick smooth paper, the careful finish and tasteful illustrations make the volume altogether unique in observatory publications.

But the chief purpose of the book is to supply "an atlas of representative stellar spectra." The methods of taking the photographs of stellar spectra and the description of the spectroscopes employed, and of certain other details, occupy Chapters III. to V. Chapter VI. is the chief chapter of the book, treating, as it does, of the types of stellar spectra, the interpretation of their differences, and their arrangement in the order of their evolution. In this chapter great stress is laid upon a subject of great importance, namely, that the conditions of the photosphere and absorbing atmosphere on which the character of the spectrum of a star depends, must be determined, not alone by temperature, but also by the force of gravity in these regions, a force which will become greater as the star continues to condense.

Chapter VII. is in explanation of Plate II., in which are given reproductions of some 15 of the most interesting pioneer photographs of spectra of the observatory. The eighth and concluding chapter describes and discusses the magnificent series of spectra on Plates III. to XII., the last two plates of which are given to practically a new research, the comparison, that is to say, of the spectra of the two components of double stars.

One subject to which Sir William and Lady Huggins have given great attention, namely, the examination of the spectra of the Wolf-Rayet stars, is not dealt with here, but we note that this is Volume I. The possession of a book at once so beautiful and so important will render all astronomers the more desirous to see its successors. Rich as are the treasures which are here displayed, they are far from exhausting the mine from which they are drawn.

Astronomical and Physical Reseaches made at Mr. Wilson's Observatory, Daramona, Westmeath.

This most valuable volume is divided into two parts. The first consists of a series of papers communicated to the Royal or the Royal Astronomical Society, and written by Mr. W. E. Wilson, either alone or in conjunction with Prof. Fitzgerald, Prof. Minchin, Dr. Rambaut, or Mr. P. L. Gray. The second is an appendix containing a few examples of the photographs, taken at the observatory, of star fields and clusters, or of nebulæ. These are silver prints, and though, perhaps, no copy whatever can do full justice to the detail and preciseness of the original negative of an astronomical subject, yet these prints give a wide field for study, and are themselves exceedingly beautiful. With several of the subjects we are already familiar in the volumes issued from Crowborough by Dr. Isaac Roberts, F.R.S. Of these we more particularly mention the nebulæ H V. 14 Cygni, which so greatly resembles a column of smoke broken and blown by the wind; the ring nebula in Lyra; and the spiral nebula M. 51 Canum Venaticorum.

In the first part of the book Mr. Wilson approaches from a new side many of the moot questions in solar physics. The investigation throws light upon the level of sunspots, a point much discussed a few years ago both in the "Journal" and elsewhere. In his experiments "on the thermal radiation "from sunspots" carried on in 1893 and 1894, Mr. Wilson found that the radiation from the umbra of a spot did not vary—certainly did not consistently increase or decrease, as the spot moved across the solar disk. In other words, the ratio of radiation from the umbra of a spot to that of the centre of the sun's disk is approximately constant. But if spots are depressions in the sun's surface, then the absorption should increase as the spot approaches the limb, and the radiation should therefore diminish. If, however, the spots are above the level of the sun, the absorption would not vary with their distance from the centre of the disk, and therefore the radiation should also remain the same, as Mr. Wilson's experiments seemed to establish. Mr. Wilson's investigations were carried out at a period of maximum spots, and do not agree in their results with those conducted by Prof. Langley at a minimum period, so the question still remains open as to whether the level of the spots may not vary according to time in the solar cycle. Prof. Langley's experiments were carried out, however, when there were but few spots to observe, and his methods do not appear to us to be the best possible for settling the point. Mr. Wilson compared the radiation from the umbra directly with that of the cèntre of the disk; Prof. Langley with two regions on the sun's disk which varied in position, and it seems to us that in this way some uncertainty must be attached to the value of the standard radiation.

Astronomischer Jahresbericht, mit Unterstützung der astronomischen Gesellschaft, herausgegeben von Walter F. Wislicenus, I. Band enthaltend die Litteratur des Jahres 1899. 8°. Berlin. G. Reimer, 1900; pp. xxii., 536.

This work contains not only a list but also descriptions of the various books and papers on astronomical subjects published in 1899. The digging up of papers on any special subject from the proceedings of learned societies and from periodicals is so laborious a task that the thanks of astronomers

are justly due to the compiler of this book. It is divided into four parts, containing 74 sections and comprising 1,768 entries. An idea of its great usefulness will be gathered from the following:—Part I embraces the publications of Institutes and Societies, Annuals and Ephemerides, the Cosmogony, the History of Astronomy, Biography, &c. The Second Part contains Spherical Astronomy, Refraction, Aberration, Precession, Parallax, the Polar motion, the Calendar, Celestial Mechanics, Instruments, Eclipses, Meteors, Star Catalogues, the Planets, Stellar Parallax, &c. In the third Part 563 entries are devoted to the various sub-divisions of Astro-physics, while those in the Fourth Part relate to Geodesy and Nautical Astronomy. An Index of Authors' names completes the work.

The Telescopic Planets: Application of Laplace's Theory. C. de Freycinet. Paris: Gauthier-Villars, 8° p. 22.

When Laplace formulated the Nebula Hypothesis only four asteroids were known; at present there are over 400 telescopic planets describing orbits between Mars and Jupiter. M. de Freycinet has applied a statistical method to the discussion of the orbits of these bodies, on the assumption that they arose from a ring or rings thrown off by the contracting solar nebula. The hypothesis that they belong to more than one such ring is shown to be a very probable one, not only from the great extent of the space covered by their orbits, but also from the fact that at very unequal distances planets are found with orbits of small eccentricity, these being considered to have arisen on or near the external surface of a ring, which would initially have had a sensibly circular path. The planets may be divided into three groups, according to the inclination of their orbits to the plane of the sun's equator; in each of these three groups the mean distance from the sun is nearly the same, and the mean eccentricity of the orbits increases with the inclination. Also, dividing the whole number by a sphere of radius equal to the mean distance the mean eccentricity of the orbits of the external planets is less than that of those of the internal ones. These results are shown to follow from the theoretical consideration of the complete breaking up of a ring. M. de Freycinet is of opinion that there were probably five such rings (omitting extreme cases), each of an average thickness of 0·29, the radius of the earth's orbit being taken as unity.

Statistical calculations are not always convincing, but there is certainly a striking agreement between the theoretical and observed results.—H. S.

Traité de Magnétisme terrestre, par E. Mascart. (Paris: Gauthier-Villars, 1900.)

We have here, in one volume, a very complete treatise on the science of magnetism, with a large number of remarkably clear engravings. The properties of magnets of all kinds are first explained, and then the theory of the earth's magnetism is fully developed with the help of mathematical reasoning and of numerous charts and diagrams. The last chapter of the book is an interesting one on the magnetism of ships. This work, which was written for the benefit of naval officers, and which contains a summary of all the important discoveries and researches that have been made in the subject up to the present time, will certainly be of the greatest possible value to all scientific students of magnetism, as well as to astronomers and navigators, who will find in its pages an explanation of all the problems they may have to solve in this science.—V. J. B.

Total Eclipses of the Sun. By Mabel Loomis Todd. New and revised Edition, with Introduction by David P. Todd. 8°. London, Low, Marston, & Co., 1900; pp. xvii., 273. 3*s*. 6*d*.

Although the authoress modestly says that this volume is not written for astronomers, there are, doubtless, many who will heartily welcome this new and enlarged edition of her little book. Six years have elapsed since the first appearance of the work, and in that period there occurred four total solar eclipses, though at the date of publication that of last May was still in the future. Of the first three of these, the one most looked forward to by European astronomers was that of 1896, by reason of the comparative

proximity of the shadow-track. Mrs. Todd tells concisely how the hopes of so many observers were frustrated by clouds during this eclipse, and how success attended others. A good account is given, too, of the observations two years later in India, accompanied by a (not very good) reproduction of Mrs. Maunder's photograph of the long coronal streamer. Among the illustrations are more than 30 views of the corona as seen during different eclipses. Another useful feature is the insertion of bibliographies of books and papers treating on the Solar Prominences, and on the corona; their value would, however, have been much increased had they been brought up to date. Some statements also on p. 161 should have been modified; in fact, pp. 1–212 remain exactly as in the first edition.

So much of value has been brought into so small a compass, and set forth so clearly, that it may appear hypercritical even to suggest that the frontispiece and the cut on p. 95 present a marked contrast to the other illustrations in the book. A copious index fitly concludes this excellent work.

The Path of the Sun: Its Orbit and Period of Revolution, demonstrated with an exposure of the fallacy of the precession of the equinoxes. By William Sandeman, F.C.A. Publishers—Manchester, Sherratt and Hughes; London, Simpkin, Marshall, & Co.

Mr. Sandeman believes that the shift in the position of the first point of Aries is due, not to any precessional motion of the earth's axis, but to the motion of the sun in a great orbit which he traverses in the course of the precessional year. The proof is conducted strictly on the lines of the Bellman in the "Hunting of the Snark"—

"I have told you thrice,
What I tell you three times is true."

Mr. Sandeman's proof, however, is stronger than that of the Bellman's by the number of times he repeats his assertion in excess of the mystic triplet. Other proof he offers none.

Researches into the Origin of the Primitive Constellations of the Greeks, Phœnicians, and Babylonians. By Robert Brown, Junr., F.S.A. Vol. II. Williams and Norgate, 14, Henrietta Street, Covent Garden, London, W.C.

We are glad to welcome the appearance of the second volume of Mr. Brown's work on the "Primitive Constellations." The first volume could only be regarded with mingled feelings. The scholarship, the labour and research, therein displayed called for grateful recognition, but the handling of the materials which Mr. Brown brought together was far from happy. The second volume is in all respects an advance on the first. It deals with a subject of the profoundest interest, and yet which very few are able to handle, namely, the evidences as to the primitive astronomy of the old world which are supplied by the Euphratean tablets which have recently come into our possession. It was a work that needed doing, and we are exceedingly glad that Mr. Brown has undertaken it and brought it to so successful a conclusion.

The first subject dealt with is the "constellations in the Babylonian creation scheme." In this chapter Mr. Brown reconstructs from three small fragments the Euphratean planisphere. Chapter XI. is a detailed examination of the "tablet of the thirty stars," in the identification of which he differs widely from Prof. Hommel. The identification of certain groups of seven stars, recognised by the early inhabitants of the Euphrates valley, occupies Chapter XII. The thirteenth chapter is devoted to giving again the considerations which fix the celestial equator of Aratos as really referring to a date 1,800 years before his time, the great importance of the subject more than justifying its being thus treated anew.

In the two concluding chapters Mr. Brown attempts to reconstruct the methods by which the constellations were originally mapped out. Mr. Brown considers that essentially the constellations are symbolical representations

of leading natural phenomena, above all, of those connected with the sun. "The sun is personified and regarded as a shepherd, a warrior, an archer, "&c.," whilst darkness, the opponent and enemy of the solar hero, was "portrayed as a dragon, huge serpent, scorpion, &c." The idea is worked out through the whole of the two volumes with inexhaustible ingenuity, but is often pushed beyond all probability or reason. A most amusing instance occurs on page 192, where, after a very fanciful comment on the "frog" in the hoof of the Centaur, Mr. Brown adds, "From this, as from so many "instances, we learn as a general principle, to exclude arbitrary fancy and "invention." A few pages further he reads from a tablet, "Forty degrees "= the circuit of the sun; sixty degrees = the "circuit . . . . From "these statements it follows, therefore, that the scribe was perfectly acquainted "with the obliquity of the ecliptic." There seems a chasm between the premises and the conclusion in this case only to be bridged by a very free use of assumptions.

Notices of the Association.

The Council hereby give notice that the Annual General Meeting of the Association will be held at Sion College, Victoria Embankment, on Wednesday, October 31, at 5 p.m., to receive the Reports of the Council upon the work and progress of the Association during the past Session, together with the Reports of the Treasurer and Auditors on the financial state of the Association, and of the Scrutineers of the Ballot for the election of Officers and Council for the ensuing Session.

The Council greatly regret that continued ill-health has compelled Mr. W. F. Denning, F.R.A.S., to resign the direction of the Meteoric Section.

Mr. G. F. Chambers, F.R.A.S., having completed the Catalogue of Red Stars which he had proposed as his programme of the Coloured Star Section, has resigned the Directorship of that Section.

Mr. Walter Maunder, F.R.A.S., in view of his probable absence from England for several months during the coming Session has resigned the post of Editor.

In order to fill up the vacancies thus created, the Council have nominated the following gentlemen to the respective offices, subject to the confirmation of the Annual General Meeting on October 31 :—

Editor.—Mr. F. W. Levander, F.R.A.S., 30, North Villas, Camden Square, N.W.

Director of the Meteoric Section.—Mr. W. E. Besley, 75, The Chase, Clapham Common, S.W.

Director of the Coloured Star Section.—Mr. Walter Maunder, F.R.A.S., 86, Tyrwhitt Road, St. John's, S.E.

The Ordinary Meetings of the Session will be held on 1900, November 28, December 19; 1901, January 30, February 27, March 27, April 24, May 29, and June 26.

The following papers have been received and are in type, but have been necessarily held over for want of space:—

Considerations on the Double Canals of Mars, E. M. ANTONIADI, F.R.A.S.

On an Improved Means of determining the Meridian Axis of an Observatory for Building and Erecting Purposes, J. J. HALL, F.R.A.S.

Astronomy with the South African Field Force, JOHN T. BIRD, CHAPLAIN H.M. FORCES.

Remarks upon the Jupiter Report, EDWIN HOLMES.

Reply to the above, ARTHUR COTTAM, F.R.A.S., DIRECTOR OF THE SECTION.

Victoria Branch.

NEW MEMBER OF THE ASSOCIATION.

GEORGE HARDESS, 183, Moore Street, Moonee Ponds, Melbourne, Australia.

Meteoric Section.

On my appointment to the Directorship of the Meteoric Section, I wish to draw the attention of Members to the following scheme of proposed observations:—

First, as to the expected showers for the period until the summer of 1901.

Leonids.—The November full moon this year falls on the 6th of that month, and hence, though moonlight will be a hindrance to the observation of early Leonids, it will not greatly interfere with the display about the middle of the month. It is suggested that watches be kept from 11^h onwards on November 13 to 16, inclusive, while if observations be continued for two or three nights longer, some valuable evidence as to the stationary or shifting character of the radiant-point may be forthcoming. Notes with reference to the shower from Members of the Association who have not joined the Section will in addition be welcomed.

Andromedids.—These meteors should be looked for on the evenings of November 23 and 24.

Geminids.—As in the case of the Leonids of the preceding month, moonlight will to a large extent obliterate early traces of this shower. Observations may, however, be made before moonrise on December 9 to 15, with a special view to ascertaining whether the radiant does or does not undergo displacement.

Quadrantids.—On the first three nights of January, when these meteors may be expected to return, the moon will be closely approaching the full phase. The shower will probably be of sufficient strength to manifest itself in spite of this.

Lyrids.—Observations of the Lyrid shower having been comparatively few in recent years, it is proposed to devote particular

attention to it in 1901. Watches should be begun in the middle of April and continued until April 25, as the question of the movement or otherwise of the radiant point yet remains to be settled.

Aquarids.—These meteors are somewhat difficult to observe, as the radiant-point only rises above our horizon at about $13^h\ 45^m$. Their epoch falls about April 29 and 30, and in the first week of May. Some members of the shower are very brilliant, and well worth the endeavour to see them.

Secondly, it is proposed to obtain observations at suitable periods of minor showers. A good opportunity for such work will occur between the epochs of the Quadrantids and Lyrids when no principal showers are due. Simultaneous watches will be arranged from time to time for the purpose of procuring duplicate observations of meteors, and it is hoped that any Members of the Section who wish to take part in this branch of the work but have not already done so will inform me of their willingness to help.

Lastly, I would appeal to other Members of the Association in addition to those of the Section to send notices of any bright meteors or fireballs they may observe, and to forward accounts of such bodies as given in the press. Also I would ask for their assistance, if it can conveniently be given, on the occasions of the returns of the greater periodic showers.

WALTER E. BESLEY,
Director of the Section.

75, The Chase, Clapham Common,
London, S.W.
1900, October 12.

Short Titles of Additions to the Library from September 1, 1899, to June 30, 1900.

Adelaide Observatory, Meteorological Observations in 1896	fol.
Aldis, W. S., Numerical Computation of the Functions $G_0(x)$, $G_1(x)$, and $J_n(x - \sqrt{i})$	8vo.
Annuaire pour 1900 (Bureau des Longitudes)	8vo.
Antoniadi, E. M., Further Notes on Saturn's Crape Ring	8vo.
—— Le Maximum des taches solaires en 1893	8vo.
Astronomische Nachrichten, Vols. 149–151	4to.
—— Rundschau, Vol. 1.	8vo.
Astrophysical Journal, Vol. 10.	8vo.
Ball, R. S., Starland	8vo.
Barnard, E. E., Micrometrical Measures of Jupiter's fifth Satellite. The motion of the lines of its Apsides	8vo.
Baxendell, J., Report of Observations at Southport, 1899	4to.
Berlin, Vereinigung von Freunden der Astronomie, Mitteilungen, Vol. 9	8vo.
Boccardi, G., Latitudine di Collurania	4to.
Brussels; L'Observatoire, Annuaire, 1900	8vo.
—— Société belge de l'Astronomie, Bulletin, Vol. 4	8vo.
Bulletin Astronomique, Vol. 16	8vo.

Cape Observatory; Annals, Vol. 2, part 2 - - 4to.
Ciel et Terre, Vol. 20 - - - - - 8vo.
Clark and Sadler, The Star Guide - - 8vo.
Cortie, A. L., The November Meteors - - 8vo.
—— The Total Solar Eclipse, 1900, May 28 - - 8vo.
Crossley, Gledhill, and Wilson, Corrections to Handbook of Double Stars - - - - 8vo.
Earth Measured - - - - - - 8vo.
Eclipse of the Sun, 1900, May 28 (in Portuguese) - 8vo.
English Mechanic. Vols. 69, 70 - - - fol.
Flammarion, C., Popular Astronomy, translated by Gore 8vo.
Galileo, G., Sidereal Messenger, translated by Carlos - 8vo.
Greenwich; Royal Observatory, Observations, 1897 - 4to.
—— —— Report of the Astronomer Royal, 1900 - 4to.
Hale, G. E., Second Annual Report of the Yerkes Observatory - - - - - 4to.
Harvard College Observatory, Annals, Vol. 32, part 2; Vol. 33; Vol. 42, part 2; Vol. 44, part 1 - - 4to.
—— 54th Annual Report - - - 8vo.
Himmel und Erde, Vol. 11 - - - - 8vo.
Huggins, Sir W., Atlas of Representative Stellar Spectra, Vol. 1 - - - - - - fol.
Klein, H. J., Star Atlas - - - - 4to.
Knowledge, Vol. 22 - - - - - 4to.
Lebon, E., Histoire abrégée de L'Astronomie - - 8vo.
Ledger, Rev. E., Sun, Planets, and Satellites - - 8vo.
Leeds; Astronomical Society, Journal and Transactions, 1898 - - - - - - - - 8vo.
Lockyer, Sir J. N., Recent and Coming Eclipses - - 8vo.
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Application for the Loan of Instruments.

Applications for the loan of any of the instruments belonging to the Association (*see* p. 391) should be addressed to the Secretary, Mr. J. G. Petrie, F.R.A.S., 359, Holloway Road, London, N., and will be considered by the Council at the next Meeting following the date of the receipt of the application.

Reports of the Directors of the Observing Sections.

Meteoric Section.

(Interim Report.)

THE PERSEIDS, 1900.

Although Perseids have not been recorded in 1900 in such large numbers as in 1899, on account of the moonlight nights towards mid-August, a useful series of observations, extending over almost the whole period of the shower, has been made.

Perseids began to fall immediately the first half of July had elapsed, but not enough were registered for the determination of radiants until July 23 and 24. The horary rates of the Perseids seen on these dates were about 1·3 and 1·6 respectively. The rate had risen to 2·5 by July 30, but these values are not corrected for time spent in recording. Few meteors of the shower were observed during the first week of August, but, allowing for the hindrance caused by the moon, they were fairly plentiful a few days later. The maximum seems to have occurred on August 12, this date being supported by the particulars in the following Table, combined with a consideration of the length of watches and also of the observations of Mr. W. H. Milligan, at Belfast:—Number of Perseids, $9^h\ 30^m$ to $11^h\ 30^m$ each night, August 10, 6; 11, 8; 12, 10. The Perseids were probably still in evidence as late as August 22.

A summary of the radiant positions observed is given below:—

Date.	Radiant. α	Radiant. δ	Number of Meteors.	Observer.
July 23	23°	+ 51°	5	W.E.B.
„ 23–24	24	+ 50	5	A.S.H.
„ 24	25	+ 52½	7	W.E.B.
„ 30	30	+ 54	4	E.M.A.
„ 30	31	+ 54	10	W.F.D.
„ 30—August 1	33	+ 54½	4	J.H.B.
August 7	39	+ 54	5	„
„ 11	43	+ 56½	6	„
„ 12	48	+ 58	12	A.K.
„ 14	50	+ 56	5	E.M.A.
„ 16	54	+ 58	5	W.F.D.
„ 22	59	+ 59	5	„

During the Perseid epoch many brilliant meteors were observed. The following list contains brief particulars of those of Jupiter or Venus-like brightness, which were directly contributed towards the records of the Section:—

Date.	G.M.T.	Mag.	Path. From		Path. To		Observer.
			α	δ	α	δ	
	h m		°	°	°	°	
July 15 -	10 12	♀	213	+ 28	186	+ 29	H.J.T.
„ 15 -	10 14	2 × ♀	230	+ 35	148	+ 37	C.L.B.
„ 18 -	11 31½	> ♃	18½	+ 43	23½	+ 29	A.S.H.
„ 19 -	11 48	♃	344	+ 33	329	+ 19	W.F.D.
„ 23 -	12 13½	♀	303½	+ 38½	280	+ 16	W.E.B.
„ 23 -	13 1½	♃	322	+ 9½	288	+ 1½	„
„ 24 -	10 49	♀	26	+ 44	45	+ 44½	J.H.B.
„ 24 -	10 49	♃	6	+ 21	22	+ 25½	W.F.D.
„ 24 -	10 50	♃	7	+ 34½	26	+ 37	T.H.A.
„ 24 -	10 50	♃	12	+ 19	24½	+ 25	A.K.
„ 24 -	13 25½.	♃	3	+ 22	351	+ 11	W.E.B.
„ 24 -	14 4	♀	310	− 12½	319	− 13	„
„ 28 -	12 25	♃	334	− 7	340	− 16	W.F.D.
„ 30 -	9 30	♃	29	+ 59	24½	+ 36	A.S.H.
„ 31 -	10 51	♃	345	+ 30	332	+ 13½	J.H.B.
„ 31	10 52	♀	320	+ 22½	305	+ 7½	W.E.B.
Aug. 12 -	9 27	♀	—		149	+ 47	T.W.B.
„ 12 -	10 21	> ♀	291½	+ 30	271	− 7	T.E.R.P.
„ 12 -	12 49	♃	56½	+ 68½	60½	+ 73½	A.K.
„ 13 -	9 15	3 × ♃	—		228	− 20	C.L.B.
„ 15 -	10 30	> ♀	—		107	+ 57	T.W.B.
„ 18 -	12 25	♃	357½	+ 15	3½	+ 22	W.F.D.
„ 19 -	10 36	> ♀	—		198	+ 26	„
„ 19 -	10 36½	3 × ♀	191	+ 37	182½	+ 27	T.E.R.P.
„ 20 -	10 1	> ♀	—		1	− 10	W.F.D.
„ 22 -	10 7½	♃	335	+ 46	343½	+ 41½	A.K.

The meteor of July 19, in the foregoing list, is a most important one, as confirming beyond any question the place of the Perseid radiant more than three weeks before the maximum. The object was also seen by Prof. Herschel, who rated it as bright as, or brighter than, Vega. Mr. Denning places the radiant at $17° + 50°$, but regards this as a little too far west compared with the true position. A Perseid observed at Slough, Bristol, and Clapham, on July 23, $12^h\ 12^m$, was from a radiant at $24° + 52°$.

In addition to the above, a magnificent fireball was widely observed on July 17 at $8^h\ 47^m$. An account of this object may, however, be reserved for the annual report.

The most important contemporary shower was that of 23 Aquarids from a radiant at $338° - 10°$, observed by Mr. Denning. Other well-marked showers were from $315° + 47°$, $305° - 12°$, $302° + 3°$, and $292° - 10°$. Cassiopeids were much less plentiful than in recent years.

Prof. Herschel, who has kindly added his record of observations to those sent in by Members, also registered four χ Perseids from $34° + 56°$ on July 18 and 28 to August 1.

The observers referred to in the above tables are:—E. M. A., E. M. Antoniadi, Paris; T. H. A., T. H. Astbury, Wallingford;

T. W. B., T. W. Backhouse, West Hartlepool (on August 12) and Dryderdale, near Wolsingham (on August 15); W. E. B., W. E. Besley, Clapham; J. H. B., J. H. Bridger, Farnborough; C. L. B., C. L. Brook, Meltham; W. F. D., W. F. Denning, Bristol; A. S. H., Prof. A. S. Herschel, Slough; A. K., A. King, Ilfracombe (in July) and Leicester (in August); T. E. R. P., Rev. T. E. R. Phillips, Yeovil; H. J. T., H. J. Townshend, Leeds.

WALTER E. BESLEY,
Deputy Director of the Section.

Clapham,
1900, September 29.

Solar Section.

PARTIAL ECLIPSE OF THE SUN, MAY 28TH, 1900.

Reports of observations taken at this eclipse, have been received from the Rev. Arthur East, who observed at Whitney, Oxon., with a 12-in. reflector, and also took a photograph with a fixed camera, the sun's image being allowed to trail across the plate, and exposures of $\frac{1}{90}$ second being made on an Ilford "Process" plate every five minutes so far as the clouds permitted; from Mr. Arthur Mee, F.R.A.S., who observed at Cardiff, with a 8½-in. Calver reflector; Mr. W. Alfred Parr, at Florence, with (1) a 3-in. refractor and first surface prism, power 80 for direct vision, (2) a 2-in. refractor, power 100 for projected image; Mr. Henry J. Townshend, at Leeds, with a 10-in. silver-on-glass reflector, power 111; and Mr. John Killip, Walton, Liverpool, with a 4¼-in. refractor. All the observers seemed to have enjoyed good weather conditions, and the definition is described as excellent.

Cusps.—Mr. Mee reports no irregularity, while Mr. Parr saw the cusps always sharp. The Rev. A. East observed that in the 12-in. reflector the cusps were not blunted, though in the photographs the cusps seem to be blunted, the effect being attributed to halation as the plate was not backed. Mr. Townshend reports "$3^h\ 9^m$ cusps of sun sharp, $3^h\ 19^m$ cusp (southern) notched, $3^h\ 50^m$ "south cusp under power 111 is broken and notched."

Moon's Limb.—Mr. Mee reports "mountains along lunar limb not specially conspicuous." Mr. Parr writes, "The moon's limb, "though showing slight undulations, was very sharply defined, "and exhibited no such irregularities as noticed by Mr. W. H. "Skelton in the 'Journal,' Vol. VII., No. 3, p. 148." Mr. Townshend reports "$3^h\ 22^m$ limb of moon slightly notched, $3^h\ 43^m$ "black, sharp, with minute notches on S.W. quadrant, and at "$3^h\ 57^m$ and $4^h\ 45^m$ the moon's limb seemed knotted to the S.W."

Neither Mr. Mee nor Mr. Parr could see the lunar limb off the sun, but Mr. Townshend notes $4^h\ 2^m$ "averted vision discloses "globular form of moon that overlaps the sun's disk quite 2′ "of arc apparently," the same appearance being noted to the extent of 1′ of arc at $3^h\ 57^m$ and $4^h\ 45^m$.

Effect on Daylight.—Mr. Mee reports that "at 4 p.m. daylight was positively mellowed," and Mr. Parr that "at period of "greatest phase (0·77) about 5.10 p.m. local time, the ashy grey

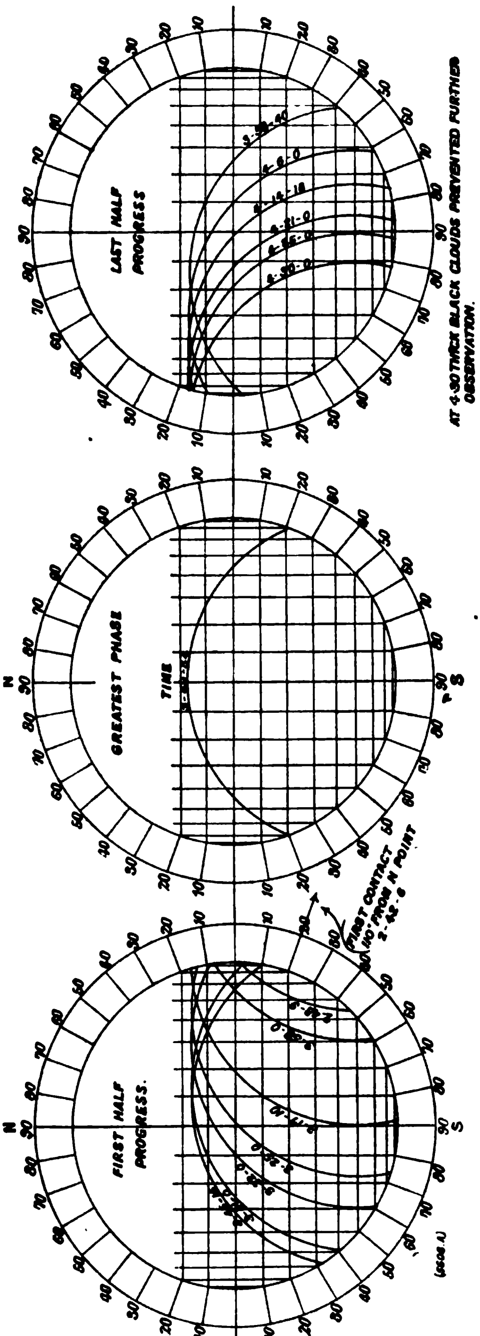


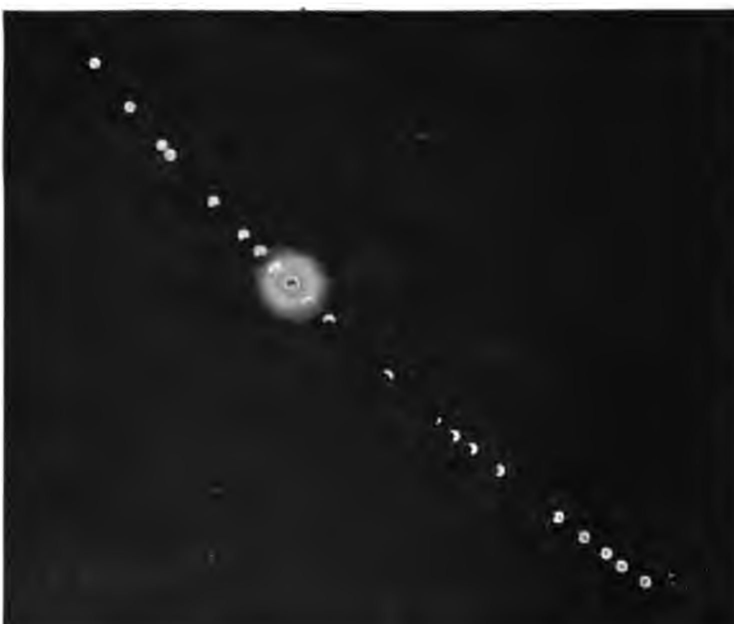
Diagram of the Partial Solar Eclipse, May 28, 1900; from observations by Mr. John Killip, Walton, Liverpool.

"light which overspread the landscape was most remarkable, all "objects losing their characteristic tints."

Darkness of Moon.—Mr. Parr notes that there was no difference of tint between the moon's limb and the central portion, and that the groups of sun-spots near centre of the sun's disk when transited by the moon, appeared very light in comparison with the blackness of the moon.

Miscellaneous Observations.—Mr. Mee records that the barometer which read 30·25 inches fell almost imperceptibly, but that the thermometer in the shade fell from 66° to 58°.

Mr. Townshend was particularly struck with the difference of focus that was required for the moon's limb and the sun, and he



PHOTOGRAPHS OF THE PARTIAL SOLAR ECLIPSE OF MAY 28, 1900.
By the Rev. Arthur East, Witney, Oxfordshire.

"actually missed all trace of sun-spots because I persisted in "minutely following the moon's limb." If the centre of the field of the object-glass was used both for viewing the sun and the moon's limbs then it would seem that such an effect was merely subjective; otherwise the difficulty would disappear if the centre of the field were used for one object, and the side of the field of view for the other. The border of ultramarine tint of blue observed round the moon's limb could be thus easily accounted for.

Times of Phases.—Professor Abetti, of the Arcetri Observatory, Florence, communicated to Mr. Parr the following times for the European central meridian.

First contact $16^h\ 7^m$, greatest phase $17^h\ 10^m$, last contact $18^h\ 12^m$.

Mr. Townsbend observed, greatest phase, $3^h\ 57^m$ G.M.T.; last contact, $4^h\ 52^m\ 31^s$ G.M.T. Mr. Mee reports the eclipse as over at $4^h\ 56^m\ 30^s$ G.M.T., and the two sun-spot groups as reached at $3^h\ 10^m$ and $3^h\ 28^m$, and uncovered at $4^h\ 9^m$ and $4^h\ 25^m$ respectively. Mr. Parr records the transit of the central group of spots by the moon at $4^h\ 29^m\ 30^s$ local time.

Mr. John Killip projected the sun's image by means of his 4½-inch equatorial refractor on to a graduated screen in a conical box attached to the eye-piece. The size of the solar image was 7¼ inches in diameter. By means of this graduated screen, on which a beautifully distinct image was visible, the following diagram of the phases of the eclipse was produced, the time given being approximately exact. The first contact was noted at 110° from N. point at $2^h\ 42^m\ 6^s$ G.M.T.

On the Rev. A. East's single plate (6 × 4½) 22 images of the sun are shown, the first three and the last one being of the uneclipsed sun. The images are 1·55 mm. in diameter, and the times at the exposures are (the time of the last exposure not being given)—

h	m	s	h	m	s	h	m	s
2	22	0	3	2	30	4	5	0
	32	0		7	30		10	0
	42	0		12	30		15	0
	45	0		17	30		22	0
	57	0		22	30		32	0
				27	0		38	0
				34	0		45	0
				45	0		51	0

A. L. Cortie,
Director of the Section.

Astronomical Publications.

The apparent Enlargement of the Sun and Moon near the Horizon.—*T. J. J. See.*—The enlargement is entirely psychological, and is due to the fact that we mentally refer the base of the celestial vault to a greater distance than the part immediately overhead. This is attributed to our experience of the strata in which the clouds move. If a cloud overhead is at a distance of 1·3 kilometres, a cloud on the horizon at the same vertical height will be at a distance of 120 kilometres. Few people make the effort to see clouds so low as this, but most are accustomed to notice them when at a distance of 10 or 20 kilometres, and still near the horizon. Hence we come to conceive the dome of the heavens as having a horizontal extension of 10 or 20 times its vertical height. (P.A., September.)

THE TOTAL SOLAR ECLIPSE OF 1900, MAY 28. *E. Walter Maunder.*—Some of the most important results of this eclipse, one which has been most prolific, are noticed in a long and interesting paper and a fine drawing, by Miss Martin Leake, of the corona (S.W. quadrant) is reproduced. Among the many points touched upon, perhaps the most remarkable is the presence of "black rays" in the corona, as shown in the long-exposure photographs of Mr. and Mrs. Maunder. There is little doubt that these coronal rifts are neither contrast effects nor mere interspaces between bright rays, but are caused by the interposition of actual dark absorbing matter between ourselves and the diffused coronal glow. If such be the case the form of the corona is not wholly an emission, but partly an absorption effect. (**Kn.**, Aug. 1900.)

THE TOTAL SOLAR ECLIPSE AS OBSERVED BY THE SMITHSONIAN EXPEDITION.—Wadesboro, in Northern Carolina, was the station selected for the expedition under the charge of Prof. Langley. Six photographs were obtained during totality with a 12-in. achromatic lens of 135 feet focal length, lent by Prof. E. C. Pickering. The lens was fed by a cœlostat of 18 inches aperture, and the exposures ranged from one-half to 16 seconds, the moon's disk is 15 inches in diameter; and the few plates as yet developed show great wealth of detail. Three other plates were exposed immediately after third contact. A 5-in. lens of 38 feet focal length, lent by Prof. Young, was pointed directly at the sun, and photographs were secured on plates 11 by 14 inches, moved by a water-clock. Mr. Abbot and Mr. Mendenhall using a bolometer in connection with a 7-in. siderostat, found that the corona gave positive heat indications as compared with the moon. Prof. Langley, using the same 5-in. visual telescope as at Pike's Peak in 1878, found little indication of the finely divided structure of the inner corona he had then recorded. The coronal streamers did not give him the impression of being connected with the prominences, though the relation of some of them to the solar poles was manifest. Plates taken in search for intra-mercurial planets have not yet been carefully examined, but the brightness of the sky renders the prospects of success very doubtful, though images of Pleione (mag. 6·3), and some fainter stars are recorded. Equatorial streamers were followed with the naked eye to distances of 3–3½ solar diameters and photographed to distances of 3–4 diameters. Several other lines of research were also followed, and many valuable data obtained. (**Nat.**, July 12.)

THE TOTAL SOLAR ECLIPSE OF 1900, MAY 28.—**P.A.** contains a reproduction of a photograph by Mr. Burckhalter, in which the exposure varied from $0^s{\cdot}04$ at 16′ from the limb to $8^s{\cdot}0$ at 110′, the result being that prominences, inner corona, polar streamers, and equatorial extensions of outer corona are all shown on the same plate. There are also photographs of several of the observing stations at Wadesborough, N.C., including that of the British Astronomical Association.

Prof. C. A. Young in the "Independent" of August 30, gives an account of the work of the Princeton party. The last contact was photographed with one half-second exposure, giving a positive of the sun's disk, but as sharp as the negatives of the first

exposure. Prof. Young had intended to measure the position of the "1474" line, but failed to see it at all, whilst his assistant caught only a glimpse of it.

From Norfolk, Va., the inner was seen by A. C. de P. P. Maury with the naked eye for some ten seconds after third contact. (P.A., September.)

THE TOTAL SOLAR ECLIPSE, U.S. NAVAL OBSERVATORY PRELIMINARY RESULTS. *S. J. Brown.* — Three stations were established, two on the central line of eclipse at Pinehurst and at Barnesville, and one near the northern limit of totality near Griffen.

At the central line stations photographs of the corona were obtained with 5-inch photo-heliograph lenses of 40 feet focus, the exposures ranging from two seconds to 45 seconds. The two seconds plates gave details of the middle and inner corona, and the 45 seconds plates gave fine detail of the outer corona one diameter from the moon's limb.

Smaller cameras were also used, and the effect of using colour screens limiting the light to the green part of the spectrum was tried at both central eclipse stations, the screens used containing solutions of picrate of copper.

It was found as a general result that such screens are effective in cutting out sky glare, and long exposure photographs obtained with them show a greater extension of the coronal rays than similar photographs obtained without the screen. In one case (with the screen) the corona can be traced on the west side beyond Mercury.

The spectroscopic results unfortunately appear to have been rather meagre, although an extensive programme of work was arranged at all three stations. A new feature was the employment of the concave grating used with slit, and quartz image-forming lens. Two of these were used at Griffin and one at Pinehurst, but all of them failed to get any result; this, in two cases, is ascribed to mal-adjustment of the image on the slit.

Two plane gratings were also used, and one of these, in charge of Dr. Huff at Pinehurst, secured some fine flash spectrum photographs in which a great amount of detail is shown near H and K. One of his plates also shows four new coronal lines in the ultra-violet.

Good photographs of the flash were also obtained by Prof. Lord with a 4-inch prismatic camera. These were obtained on Erythro-plates, and include all the visible spectrum, about 150 lines being shown between D and Hγ as well as 6 or 8 lines between D and C in the red. Prof. Lord gives a very interesting detailed account of his operations during totality.

Mr. Jewell, at Griffin, with a grating binocular, made visual observations on the reversing layer. As his station was near the limit of totality, he was able to watch the gradual appearance and disappearance of the bright lines to great advantage. He says that at second contact the field of his spectroscope was literally filled with bright crescents which faded out very gradually, some lasting eight or ten seconds after second contact.

The great advantage of a station near the limit of totality was shown by the ease with which the chromospheric spectrum was

observed at Griffin compared with the failure of two observers at Pinehurst using instruments of identical construction.

THE TOTAL SOLAR ECLIPSE OF 1900, MAY 28.—*H. C. Wilson.*—The Carleton College expedition was located at Southern Pines, N.C. Four photographs of the corona were taken with an 8-inch Clark photographic telescope of 9 feet focus, and two instantaneous exposures were made a few seconds after totality. Plates were exposed for 93 seconds in a 6-inch and in a 2¼-inch camera for outer extensions of the corona and bright intra-mercurial planets. Four plates were exposed in a small prismatic camera. Three miles off, at Pinehurt, the U.S. Naval Observatory party took five photographs of the corona with a 5-inch lens of 40 feet focus, and a number of spectrographs, Dr. Ames making 15 exposures with a 6-inch concave grating of 15,000 lines to the inch, giving a spectrum 2 feet long. One of a battery of cameras on a long polar axis was provided with a colour screen allowing only green rays to pass, the hope being to obtain a photograph of the corona in light due to coronium. Two other 40-foot telescopes were used at Barnesville, Ga., by Profs. Updegraff and See, and at Winsborough, S.C., by Prof. Stone. A spectroscopic expedition was situated at Griffin, Ga., near the edge of the shadow track, in order to obtain a long duration of the "flash" spectrum. Prof. Humphrey here had a concave grating of 21 feet focal length. At Wadesborough were expeditions from the Smithsonian Institution, Princetown University, and Yerkes Observatory. Prof. Barnard made seven exposures with a 6-inch lens of 62 feet focus, fed by a 12-inch cœlostat. Prof. Frost used three slitless spectroscopes with three prisms, one prism, and a concave grating respectively. He saw only dozens of lines reverse where he had expected hundreds, and the flash spectrum was disappointing at other stations also. Prof. Young, who had intended to fix the position of the coronium line, failed to see it. Prof. Hale had intended to obtain bolometric measures of the heat of the corona, but was prevented by an unfortunate series of accidents, though he is confident from preliminary experiments that he can detect the change of heat at the edges of the great coronal streamers in full sunlight. (P.A., June.)

THE TOTAL SOLAR ECLIPSE OF 1900, MAY 28. YERKES PARTY. *George E. Hale.*—The site chosen was also at Wadesboro. The corona was photographed with eight different lenses, the principal one being 6-inches aperture and 61½ feet focus, used horizontally with a coelostat. Seven photographs were obtained with exposures from ½ to 30 seconds, and these show the great advantage of long focus objectives for photographing details of the corona. The long exposure plates also show four stars, the faintest being of the 6·5 magnitude.

Photographs obtained with smaller lenses show the outer extensions, but in no case do the streamers reach more than three-fourths of the distance to Mercury.

Spectroscopic Results.—Three slitless spectrographs were used; a prism train with photographic objective, a concave grating used direct without slit or lens, and a plane grating with visual lens.

Successful photographs were obtained of the first and second flash with the prism train and the concave grating spectographs. The latter gave a negative showing 110 lines between H γ and H δ in sharp focus.

Heat Radiation of the Corona.—An attempt was made to measure with a bolometer the radiation from the bright and dark regions of the corona, but the apparatus, which was in perfect adjustment just before totality, failed at the critical time. Measures were, however, made after totality which showed no certain difference between the radiation of the sky alone and the sky plus corona. (**Ap. J.**, July.)

THE TOTAL SOLAR ECLIPSE OF 1900, MAY 28. PRINCETON PARTY. *C. A. Young.*—These consisted of photographic and visual contact observations, drawings, and photographs of the corona, visual observations of the flash spectrum, and lastly, visual observations and photographs of the green corona line.

Excepting the last, the results were generally successful; it was found, however, impossible either to see the corona line or to photograph it with the apparatus used. (**Ap. J.**, July.)

DARK MARKINGS ON THE SOLAR CORONA. *W. H. Wesley.*—On the photographs of the corona of 1871 appears a small black spot about 9′ from the sun's limb in the equatorial region, which it seems impossible is an interspace between the coronal rays. Curious dark markings are also to be seen on the photographs of the eclipse of 1896, which, from their form, it is impossible to regard as interspaces. In 1898, however, appear dark markings in the form of rifts, which would appear to be actually darker than the sky. On Mr. Maunder's negatives, taken during the eclipse of May last, are certain dark streaks of much the same character as those of 1898, but, unlike those, they are most easily seen. A narrow, slightly curved, dark ray near the centre of the southern streamers has a distinct termination at a distance of about half a lunar diameter from the limb, a termination, in fact, more definite than those of the bright coronal rays. It seems decidedly darker than its background of sky or faint coronal light. If this marking is merely a rift or interspace, it must be a rift *closed at its outer extremity*, which appears a most improbable supposition. Some excellent negatives by Miss Bacon, taken in America, clearly show the same markings. This paper is accompanied by the reproduction of a drawing of extreme beauty by Mr. Wesley from Mr. Maunder's photographs. (**Kn.**, October 1900.)

ECLIPSE PHOTOGRAPHY. *Francis E. Niphei.*—In eclipse photography, an appreciable time is required to secure delicate details, but if the time is too long the plate will fog, and then a restraining developer will cause a loss of these very details. In a paper recently published by the Academy of Science of St. Louis, the writer states that a plate which will develop as a zero plate in a dark room will develop as a positive in a light room. If the film is first exposed to lamplight until it is all converted into the zero condition, it may then be exposed in the camera for a minute or for four hours to a brilliantly lighted landscape, and superb results obtained. The tendency to fog when the exposure

is too short is corrected by taking the developing bath nearer the light. The method promises valuable results in the approaching eclipses of long totality, but preliminary experiments will be necessary. (**Nat.**, July 12.)

In a subsequent communication, p. 396, Prof. Niphei describes the process adopted to convert a plate into the zero condition. (**Nat.**, August 23.)

Magnetic Effects of a Total Solar Eclipse.—Observations were made at several stations on May 28, under the direction of Dr. L. A. Bauer. The declination at all stations was increased, 20″–40″ if east, decreased if west, the horizontal intensity was increased for a brief period after the time of totality. The principal effect always occurred some minutes after the time of totality, and was as if part of the night hours had been interposed. The observations and results are to be published in a Bulletin of the United States Coast and Geodetic Survey. (**Nat.**, July 26.)

A Suggested Explanation of the Corona. *J. Scheiner.*—The absence of dark lines in the spectrum of the corona indicates that the light is due to incandescent solid or liquid matter, and is not reflected sunlight.

It is suggested that this incandesence is simply the result of direct solar radiation acting on solid or liquid meteoric particles.

Assuming that the particles are spherical in form and small enough to acquire a stationary condition of temperature in a very short time, it is computed that a temperature of 4160° C. (absolute) would be attained at a distance from the photosphere equal to slightly less than half the solar radius.

This temperature, however, would only be reached if the particles were "absolutely black"; in the actual case of meteoric matter at the distance mentioned the temperature would be lower. Although it is not possible to compute the actual lower limit of temperature, there can be little doubt from the above result that it would be well above the temperature of incandescence. (**Ap. J.**, July.)

Jupiter and his Markings. *W. F. Denning.*—The Jovian spots are reviewed and described, together with their rotation periods, appearances, disappearances, and other kindred phenomena, and the writer is of opinion that the time has now come when all observations of Jupiter made at each opposition of the planet should be combined and discussed. The greater the number of observations the greater approach to accuracy there will be. (**Kn.**, September 1900.)

Eros and the Astrographic Conference.—The fourth meeting of the Conference met at Paris on the 19th July, and a special committee was appointed to take charge of the aproaching opposition of Eros. A list of the resolutions submitted by this committee to the general conference is given. (**Kn.**, September 1900.)

THE DIAMETERS OF THE PLANETS NEPTUNE AND URANUS.—*Dr. T. J. J. See* has obtained a series of observations of the apparent diameters of these planets with the 26-inch refractor of the United States' Naval Observatory, Washington, and entered into an investigation, discussing and comparing the results with measurements previously made with other instruments, from the times of the discovery of the two planets in question. The diameter of Neptune was measured by Galle and by Encke in the year of its discovery, 1846, and determined to be nearly 3″ at mean distance. Subsequent observations, however, made with larger instruments have reduced this value from time to time, the diameter having "shrunk with the increased perfection of astro-" nomical measurement." The result of Dr. See's own observations between October 1899 and January 1900 is that it scarcely, if at all, exceeds 2″. With regard to Uranus, the diameter according to his determination, is also somewhat smaller than was formerly supposed, amounting to 3″·3 at mean distance, which represents an actual diameter of 28,530 miles. The disk, he finds, indicated to be quite circular; and he suggests that the oblateness observed by Professor Barnard in 1894 was not real, but due to atmospheric currents, which has been known to produce similar apparent effects on stellar images. (**Ast. Nach.**, No. 3665.)

THE ORBIT OF THE SATELLITE OF NEPTUNE.—*Prof. T. J. J. See* has made a new investigation of the orbit of the satellite of Neptune from observations obtained with the 26-inch refractor of the U.S. Naval Observatory, Washington, during the opposition of 1899–1900. The value he obtains for the mass of the planet compared with that of the sun is $\frac{1}{18445 \pm 125}$. (**Ast. Nach.**, No. 3663.)

SWIFT'S COMET, 1892, I.—In Harvard Annals, Vol. xxxii., part ii., Prof. W. H. Pickering describes observations and photographs of this comet made at Arequipa in March and April 1892, the exposures varying from 5 to 133 minutes. No traces of polarisation could be detected in either head or tail. The head consisted of a nucleus, bright envelope and outer faint envelope. The tail of two sets of rays having their origin respectively in the rear side of the inner envelope and in the outer envelope. Certain periodic differences in the appearance are attributable to a rotation of the comet about an axis passing longitudinally through the tail, and a comparison of photographs by Dr. Wolf and Prof. Barnard, gives a rotation period of 94 to 97 hours. In general it was not possible to identify particular features from day to day, but a bright condensation observed on April 6, 7, and 8 was found to recede from the nucleus at a rate which indicated a solar repulsive force on the tail equal to 39·5 times the gravitational force. The spectrum photographs are difficult to reduce, but show a very narrow bright line about λ 3,890, in the brightest region. There are no indications of hydrogen. (**Nat.**, September 20.)

VELOCITIES OF METEORS.—At the second annual meeting of the Astronomical and Astro-Physical Society of America, Dr. W. L. Elkin described experiments made at Yale ("Science,"

Vol. XII., pp. 125–6). A bicycle wheel fitted with 12 radial opaque screens makes 50 to 60 revolutions per minute in front of a camera, the time of revolution being recorded by chronograph. If the trail of a meteor is thus photographed, and also observed at a second station, the interruptions in the trail give data for computing the absolute velocities. Five trails secured in November and December 1899 give apparent velocities 50·4, 12·2, 50·3, 20·2, 36·5 kilometers per second. Correcting these for motion and attraction of the earth, the velocities relative to the sun are 34·4, 32·0, 32·4, 39·8, 34·0 kilometers per second. Comparing these with computed orbital velocities, it is found that the atmospheric retardation has amounted to 8 to 15 kilometres per second. One of the meteors was an Andromedid, and the deduced elements show that the method is susceptible of great accuracy. (**Nat.**, August 23.)

THE AUGUST PERSEIDS OF 1900. *W. F. Denning.*—The shower seems to have been a somewhat scanty one, and about the time of maximum was much interfered with by moonlight, though it furnished a considerable number of large meteors. But it is doubtful whether it has ever been more successfully observed during the last fortnight of July, and the radiants obtained from July 19 onwards show the usual E.N.E. motion in a decided manner. The positions agreed well with the ephemeris place. The radiants of six prominent minor showers were well determined at Bristol, and three others indicated. Several bright fireballs have been doubly observed, and the particulars of their paths are given. Many ordinary shooting stars have also been doubly observed, which will be tabulated for later publication. (**Nat.**, August 23.)

STRUCTURE AND CONSTITUTION OF TWO NEW METEORITES. —*Messrs. G. P. Merrill and H. N. Stokes,* in Washington Academy of Sciences, Proceedings, Vol. II. pp. 41–68, July 1900, describe the results of a minute examination of a stony meteorite which fell at Allegan, Michigan, U.S.A., 1899, July 10, and of the "Mart Iron" found in Texas in 1898. In the first 77 per cent. was of non-metallic origin, the ground mass consisting of olivine and enstatite particles with a black glassy material. Metallic iron, iron sulphide, chromic iron, and nickel were found. Of the latter meteorite, 98·3 per cent. was composed of iron, nickel, copper, and cobalt, the remainder being made up of schreibertite and a small quantity of troilite. (**Nat.**, Sept. 6.)

THE DAYLIGHT METEOR OF SUNDAY, SEPTEMBER 2. *W. F. Denning.*—This brilliant meteor was seen at about 6^{h} 55^{m}, just before sunset, at a large number of stations in the north of England and Scotland. It left a long enduring streak of white dust, which was illuminated by the sun's rays, but, as no stars were visible, it is doubtful whether the real path can be exactly ascertained. Its radiant was probably high in the northern sky, and its point of disappearance over Lancashire at an altitude of about 25 miles. (**Nat.**, September 13.)

A subsequent note gives the real path as probably from 85 miles over Richmond, Yorks, to 20 miles over Fleetwood, Lancashire, a length of 84 miles, the radiant being in Cepheus at $334° + 57°$.

Another fine meteor observed on Sunday evening, September 16, at 8^h 44^m from London, Birmingham, Oxford, and Llanelly, fell from 50 miles over Bewdley to 32 miles over Wigan, a distance of 86 miles. The radiant was at $324^\circ - 25^\circ$. (**Nat.**, September 27.)

ASTRONOMY WITHOUT A TELESCOPE.—*VII. Meteors: The Perseids.—E. Walter Maunder.*—For 6,000 years men stared at meteors and learnt nothing, for 60 years they have studied them and learnt much, and half of what we know has been taught us in half that time by the efforts of a single observer. Long years of patient work enabled Mr. Denning to demonstrate the existence of stationary radiants. There is much encouragement, then, for steady persistent observation by those who are unequipped with instrumental aid. The various points to be noted in meteor observations are fully dealt with. (**Kn.**, August 1900.)

ASTRONOMY WITHOUT A TELESCOPE.—*VIII. Four Variable Stars.—E. Walter Maunder.*—In this paper the attention of the young observer is drawn to the four variables, Omicron Ceti, Beta Persei, Delta Cephei, and Beta Lyræ, and he is given advice whereby useful observations of these stars and of variable stars in general may be secured. (**Kn.**, September 1900.)

ASTRONOMY WITHOUT A TELESCOPE. — *IX. Auroræ. — E. Walter Maunder.*—Auroral displays are dealt with in this paper, and advice for their observation is given. Stress is laid on the importance of a regular system of observations being carried on at a single station for many successive years. (**Kn.**, October 1900.)

THE HUNDRED BRIGHTEST STARS. *J. E. Gore.*—A table giving the 100 brightest stars in the heavens in their order of magnitude, with their positions for 1900.0, photometric magnitudes, spectra, parallax, and proper motions. (**Kn.**, September 1900.)

THE CHANGES OF COLOUR OF FIXED STARS.—Herr Osthoff, of Cologne, discusses a number of cases of alleged changes of colour of several of the fixed stars, notably with regard to α Ursæ Majoris, of which he gives a long series of observations of small changes of colour referred to a certain scale. But his general conclusion is that the colour of fixed stars is more constant than their brightness. (**Ast. Nach.**, No. 3662.)

LATITUDE-VARIATION, EARTH-MAGNETISM, AND SOLAR ACTIVITY. *J. Halm.*—The writer has previously suggested a connexion between the solar sunspot periods and changes in the obliquity of the ecliptic and other elements of the earth's orbit (" Journal," Vol. X., p. 224). He now gives diagrams showing frequency of magnetic disturbances, frequency of auroræ, semi-amplitudes of latitude variation, and corrections to R.A. of stars derived from observations of the sun. From a discussion of these he argues a dependence of latitude variation upon the state of solar activity, through the medium of the earth's magnetism, such that the distance between the mean and instantaneous poles decreases with

increasing intensity of magnetic disturbance, whilst the period of latitude variation increases at the same time. The half-yearly period of the earth's magnetic phenomena causes the motion of the pole to be elliptic instead of circular, and causes the axis of the ellipse to revolve in a direction contrary to that of the pole. The 11 year period and the "great" period of solar activity are both found to have their effect on the variation of latitude. (**Nat.**, September 6.)

ORIENTATION OF THE FIELD OF VIEW OF THE SIDEROSTAT AND CŒLOSTAT. *A. Fowler*.—Prof. Cornu has investigated the general laws governing the rotation of the field of view in the siderostat and heliostat (C.R., Vol. CXXX., No. 9, 1900; B.A., February 1900), and a summary of his results is given. Amongst these it may be noted that the reflected image of the pole describes a circle round the centre of the field with radius equal to the polar distance of the star observed. The period of this rotation is equal to that of the diurnal motion, but the angular velocity is not constant. In the cœlostat there is no rotation of the field so long as the telescope remains fixed, but the whole field is turned when the telescope is moved in azimuth. (**Nat.**, August 30.)

NOTE ON INQUIRIES AS TO THE ESCAPE OF GASES FROM ATMOSPHERES. (*Abstract of Paper read before Royal Society.*) *Dr. Johnstone Stoney*.—Referring to investigations by Mr. Cook and Prof. Bryan (see pp. 335, 336, 377), the author holds that the probability functions assumed by these writers for the number of molecules having a given velocity will require a large correction at the limits of the atmosphere. The reasons he gives are, first, that the number of molecules having the exceptional velocity necessary to carry them away from the earth is too small, and that there are special conditions at the limits of the atmosphere which must modify the distribution of speeds. Prof. Bryan alone takes any account of the anisotropic character of the outer strata, whilst neither makes any allowance for the incessant turbulence of the atmosphere, the great absorption of solar radiation in the outer layers, or the electrification of these regions which in connection with ascending currents probably gives rise to atmospheric prominences. It is probable that there are other ways in which nature can intervene which have also been overlooked. (**Nat.**, August 9.)

A NEW PLANETARY NEBULA. — Whilst examining on August 31, the Borrelly-Brooks Comet (*b* 1900), with the 12-in. telescope of the Lick Observatory, Mr. R. G. Aitken found that the object B.D. + 83° 357 was a nebulous body instead of a star. The 36-in. telescope showed it to be probably a very small planetary nebula, having a stellar nucleus of about $10\frac{1}{2}$ to 11 magnitude, centrally placed in a circular nebulous envelope between 5″ and 6″ in diameter. As a whole, the nebula is about as bright as a star of the 9·5 magnitude. Its place for 1855·0 is $12^h\ 29^m\ 10^s + 83° \ 21'{\cdot}8$; a 13 magnitude star precedes it $14''{\cdot}8$ in Pos. Angle 263°. (**Ast. Nach.**, No. 3667.)

NEW DOUBLE STARS.—Mr. R. G. Aitken has published a second list of 62 new double stars found at the Lick Observatory, and forming a continuation of that in **Ast. Nach.**, 3635. They were chiefly observed with the 12-in. telescope, the 36-in. being used only on a few nights when the atmospheric conditions made the measurement of very close double stars impossible with the smaller instrument. (**Ast. Nach.**, No. 3668.)

Variable Stars.

Star.	Maximum.		Minimum.		Interval in Days.	References.
	Date.	Mag.	Date.	Mag.		
	1900.		1900.			
R Aurigæ	July 23	6·9	—	—	462	**E.M.**, 111.
R Camelopardi	—	—	June 26	< 13	273	**E.M.**, 563.
R Cassiopeiæ	Aug. 9	6·9	—	—	432	**E.M.**, 111.
„	—	—	Mar. 26	13·7	474	**E.M.**, 493.
S Cassiopeiæ	Feb. 21 (?)	—	—	—	599	**E.M.**, 493.
T Cassiopeiæ	May 28	6·7	—	—	406	**E.M.**, 563.
S Cephei	Feb. 20 (?)	—	—	—	528	**E.M.**, 493.
R Cygni	Apr. 13	7·7	—	—	418	**E.M.**, 493.
χ *Cygni*	July 10	4·9	(Mag. at last max. =3·6).		414	**E.M.**, 111.
R Draconis	—	—	July 14	11·9	230	**E.M.**, 111.
S Herculis	Aug. 9	6·4	—	—	322	**E.M.**, 111.
R Ursæ Majoris	May 31	7·3	—	—	295	**E.M.**, 493.
S Ursæ Majoris	—	—	June 17	12·0	230	**E.M.**, 563.

Maxima and Minima of Long Period Variables.

(**P.A.**, 342.)

MAXIMA.

	Aug.		Aug.		Sept.
— Aurigæ (1)	4	*R Leonis Min.*	25	*S Lyræ*	7
V Orionis	4	*R Aquilæ*	26	*RW Scorpii*	7
V Virginis	4	*U Cygni*	26	*— Aquilæ* (2)	8
R Tauri	5	*X Geminorum*	26	*S Ursæ Maj.*	8
SS Cygni	8(?)	*RR Capricorni*	28	*RU Libræ*	17
RR Scorpii	8	*R Bootis*	29	*R Lyncis*	19
U Draconis	11	*R Corvi*	29	*Z Scorpii*	21
S Orionis	14		Sept.	*T Serpentis*	21
R Ophiuchi	15	*S Herculis*	1	*R Canis Min.*	22
R Vulpeculæ	16	*T Arietis*	2	*W Hydræ*	22
RR Libræ	18	*X Puppis*	3	*R Scorpii*	22
RZ Scorpii	20	*T Herculis*	4	*RU Herculis*	26
U Eriduni	23	*R Serpentis*	4	*S Bootis*	28
R Pixidis	23	*R Aurigæ*	5	*T Draconis*	30
RT Libræ	24	*T Centauri*	6	*S Hydræ*	30
V Tauri	24	*V Canis Min.*	7	*W Scorpii*	30

MINIMA.

	Aug.		Aug.		Sept.
W Persei (3)	4	*X Ophiuchi*	19	*S Camelopardi*	7
U Aurigæ	5	*Z Cygni*	20	*W Herculis*	8
U Piscium	7	*R Arietis*	21	*η Geminorum*	10
T Ursæ Maj.	8	*T Andromedæ*	22	*S Leonis*	12
RR Sagitarii	10	*R Cancri*	28	*R Canum Venat.*	17
R Leporis	11		Sept.	*U Herculis*	17
T Aquarii	14	*R Trianguli*	1	*X Libræ*	20
Y Capricorni	17	*S Delphini*	5	*U Boötis*	26
R Microscopii	18				

(1) Ceraski's, R.A., $5^h\ 20^m\ 9^s + 36° 49'$ (1900).
(2) Anderson's, R.A., $20^h\ 8^m\ 3^s + 12° 41'\cdot7$ (1900).
(3) = *V Persei* in Chandler's Third Catalogue.

Minima of the Variable Stars of the Algol Type.

(Given to the nearest hour G.M.T.)

(P.A., 343.)

Algol.

	d	h
July	3	23
"	6	20
"	9	17
"	12	13
"	26	21
"	29	18
Aug.	1	15
"	4	12
"	18	20
"	21	17
"	24	14
"	27	10

λ Tauri.

	d	h
July	4	19
"	8	18
"	12	17
"	16	16
"	20	14
"	24	13
"	28	12

U Coronæ.

	d	h
July	10	15
"	17	13
"	24	10
"	31	8
Aug.	10	16
"	17	14
"	24	14
"	31	10

δ Libræ.

	d	h
July	1	8
"	3	16
"	8	18
"	10	16
"	15	8
"	17	15
"	22	7
"	24	15
"	31	15
Aug.	7	14
"	14	14
"	21	13
"	28	13

Y Cygni.

$2P = 2^d\ 23^h\cdot9$

Even minima.

	d	h
July	2	14
Aug.	1	13

Odd minima.

	d	h
June	30	17
July	30	16
Aug.	29	15

Z Herculis.

$2P = 3^d\ 23^h\cdot8$

Even minima.

	d	h
July	1	13
Aug.	2	11

Z Herculis—cont.

Odd minima,

	d	h
July	3	13
Aug.	4	11

U Cephei.

	d	h
July	3	9
"	5	20
"	8	8
"	10	20
"	13	8
"	15	20
"	18	8
"	20	19
"	23	7
"	25	19
"	28	7
"	30	19
Aug.	2	6
"	4	18
"	9	18
"	14	18
"	19	17
"	24	17
"	29	17

W Delphini.

	d	h
July	2	13
"	7	9
"	21	19
"	26	14
"	31	9

W Delphini—cont.

	d	h
Aug.	14	19
"	19	15
"	24	10

+45°3062.

	d	h
July	2	4
"	6	18
"	11	8
"	15	21
"	20	11
"	25	1
"	29	15
Aug.	3	4
"	7	18
"	12	8
"	16	22
"	21	11
"	26	1
"	30	15

U Ophiuchi.

$P = 0^d\ 20^h\cdot1$.

	d	h
June	30	6
July	31	7
Aug.	31	8

R Canis Maj.

	d	h
June	30	8
Aug.	1	3
"	31	19

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